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ABSTRACT

Rebuild America is a program of the U.S. Department of Energy that focuses on energy-savings solutions as community solutions. It works with K-12 schools, colleges and universities, state and local governments, public and multifamily housing, and commercial buildings. This guide focuses on colleges and universities. Each chapter spells out options and provides guidance for implementing projects that can save substantial energy and money. Information is taken from successful projects implemented nationwide. Each section ends with case studies that provide examples of how the nation's colleges and universities are realizing energy savings. Four sections focus on: (1) "Project Financing" (e.g., financing options and common financial misconceptions); (2) "Clean Fuel Fleets" (e.g., biodiesal and ethanol); (3) "Combined Heat and Power" (e.g., system components and system integration and sizing options); and (4) "Emissions Markets" (e.g., air pollution and climate change programs and opportunities for colleges and universities to participate in air pollution markets). (SM)

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The Energy Smart Guide to Campus Cost Savings

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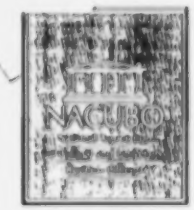
Today's Trends in

- *Project Finance*
- *Clean Fuel Fleets*
- *Combined Heat & Power*
- *Emissions Markets*

Full text available at:
http://www.rebuild.org/attachments/SolutionCenter/EnergySmartGuidetoCampusCostSavings.pdf



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Foreword

By Jay Morley, President, NACUBO
and Lander Medlin, Executive Vice President, APPA

Higher education executives today work in a climate as tough as that of any Fortune 500 company. The bear market took a heavy toll on many university portfolios. Budget shortfalls are a reality on many campuses. There continues to be a pressing need for new approaches to the oldest dilemma in education--how to do more with less, while not shortchanging students or demoralizing staff. In this high-stakes environment, business officers and facility managers play an increasingly important role, as they seek new technologies and methodologies for saving money. Energy management has emerged as a key area for these professionals. By now, a campus that isn't actively engaged in energy management is a rarity. As with every issue that challenges higher education, responses to the energy dilemma vary in complexity and scope among the nation's colleges and universities. There's one constant, however: those overseeing campus energy policy and practice confront an increasingly sophisticated array of issues, as they search for new financing mechanisms, fuel sources and energy saving technologies.

With 4,000-plus accredited, degree-granting institutions of postsecondary education in the U.S. and its outlying areas, energy efficiency improvements are impacting millions of students, faculty and staff. NACUBO and APPA are proud to have worked with the United States Department of Energy to bring you this resource guide, which is intended to give our members real-world input on a number of critical energy efficiency issues facing us today. It's also meant to alert our members to new opportunities to save both money and energy, while strengthening your institutions' contributions to environmental responsibility. And as such, it is part of our continuing services to our members. Our goal, as always, is to bring you up-to-date information you can use to make the difficult and important decisions that you face every day. Please use the resources you'll find listed in the guide, and as always, contact us if you'd like to give us feedback or if we can be of service.

Introduction

By Daniel Sze, National Program Manager, Rebuild America

We at Rebuild America salute the growing savvy of the nation's college and university facility managers and business officers, who are becoming better known to us as we serve our expanding Partnerships–now numbering 536–across the nation. Every day, Rebuild team members are working with campus managers to come up with the right energy choices for the specific needs of their buildings. Rebuild's network of professionals offers technical assistance in engineering, architecture, finance and planning, helping managers make decisions about heating, cooling, lighting, insulation, and the associated financing and environmental issues.

Rebuild's aim is to be effective at removing the barriers you face when you need to make smart decisions about energy technologies. We have a three-pronged approach to our technology deployment: we provide outstanding, individualized customer service; we introduce you to world class tools, and we help you use these tools to obtain decisional information. This guide is one means we use to connect you, our customers, with the people who are undertaking the energy work you want to be doing, and who have the knowledge and resources to get the job done. We do this in conjunction with our partners, the National Association of College and University Business Officers and the Association of Higher Education Facilities Officers, without whom we could not achieve so much. Together, we make Rebuild America what it is: a network that can help you get things done on your campus.

Let us know what you think of this guide; we'd welcome the feedback. Tell us, too, what else you'd like to see us produce in the future. Drop me a line at danielsze@rebuild.org - and let's work together to make some great things happen on campuses across the U.S.

About Rebuild America

Rebuild America is a program of the U.S. Department of Energy that focuses on energy-savings solutions as community solutions. Rebuild America began in 1994, with the mission to accelerate energy-efficiency improvements in existing commercial, institutional and multifamily residential buildings through private-public partnerships created at the community level. Today Rebuild America is helping communities across the country sort though an often overwhelming array of options for building improvements and develop and implement Action Plans that meet their needs.

The program focuses on five building sectors: K-12 Schools, Colleges and Universities, State and Local governments, Public and Multi-family Housing, and Commercial Buildings. In the College and University sector, there are 95 colleges and universities involved in Rebuild America community partnerships, as of May 2003. Collectively, they have invested $39 million to complete projects affecting over 44 million square feet with projected annual savings of $11.6 million. They have committed to undertaking energy saving projects involving an additional 81 million square feet with projected savings of more than $25 million annually.

To help communities reach their energy saving goals, Rebuild America provides an array of products and services designed to support projects in all stages of development – from planning and financing to technology and marketing support, Rebuild America has the resources to support every step of the way.

The Solution Center

The Solution Center is the place to find the answers to questions about planning and completing energy projects. Located on the Rebuild America Web site at www.rebuild.gov, the Solution Center is a collection of the best information and tools that can be found in both the public and private sectors. The concept behind the Solution Center is to provide a step-by-step guide to designing and constructing energy-efficient buildings and renovating or retrofitting existing buildings. To accomplish this, the resources are organized based on the type of project being undertaken, such as:

- Low-and No-Cost Improvements
- New Construction
- Major Renovation
- Energy Efficiency Retrofits
- Community Energy Projects

About Rebuild America

Under each project heading, the resources are organized in simple categories. They include helpful books and CDs, downloadable files and links to useful Web sites on such categories as:

- Project Planning
- Design and Documentation
- Financing and Contracting
- Technologies and System Design
- Building Commissioning
- Construction
- Facilities Management

The Solution Center provides many other resources as well, and guides visitors to the information and tools needed.

Project Assistance

In addition to the resources available in the Solution Center, Rebuild America provides an array of project support services. These services are available to participating Rebuild America community partnerships free of charge, and are provided by the experts from the Department of Energy's National Laboratories. The services are intended to supplement but not replace services that can be obtained locally or from a state-based organization. If you are a member of a Rebuild America community partnership and interested in requesting any of these services, please contact your Rebuild America program representative or State Energy Office for more information. For a complete listing of project assistance that is offered, visit the Rebuild America Web site and click on the "Services" link in the Solution Center.

For more information about Rebuild America, visit **www.rebuild.gov**, or call (252) 459-4664.

Executive Summary

Rebuild America created *The Energy Smart Guide to Campus Cost Savings* to help college and university managers sort through the opportunities and possibilities for saving energy and money on their campuses. Students and citizens are increasingly concerned about the environmental impact of campus facilities and operations. A campus is a microcosm of the larger world, and a great place to start to make the world a more sustainable place. Saving energy on campus is the right thing to do, but the bottom line is that saving energy on campus is incredibly practical, saving enormous amounts of money that could go toward educational programs or meeting other university needs. Implementing energy saving practices and off the shelf technologies at all of the nation's colleges and universities, in fact, could save over a billion dollars a year on college campuses.

Each chapter of the *Energy Smart Guide* spells out options and provides guidance for implementing projects that can save substantial energy and money. The information in this guide is taken from successful projects implemented around the country and each section ends with case studies, real world examples of how the nation's colleges and universities are realizing energy savings.

The Energy Smart Guide to Campus Cost Savings is arranged into the following four sections:

- Project Financing
- Clean Fuel Fleets
- Combined Heat & Power
- Emissions Markets

Project Financing

Energy efficient buildings and operations reduce operating costs and improve the campus environment, yet a lack of money, time, personnel and expertise can stall implementation of efficiency improvements. The financing section of this guide explains why energy efficiency projects do not require an expansion of the budget and how they create a positive cash flow. It includes strategies for creative financing, including the best ways to negotiate leases and loans, and structure debts.

Clean Fuel Fleets

Clean fuel fleets reduce emissions, limit vehicular traffic on campus, and save money. Introducing a clean fleet on campus is a high profile way of showing the university community cares about the environment and is doing something about it. The clean fuel fleets section of the guide provides information on funding and partnership opportunities and regulations,

plus a rundown on various fuels and fleet options, including ethanol, Compressed Natural Gas (CNG), biodiesel, liquefied petroleum gas (LPG/ propane), hydrogen, and hybrid and electric vehicles.

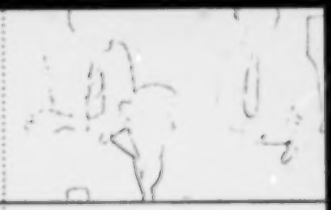
Combined Heat and Power

Many colleges have already been using Combined Heat and Power (CHP) for decades. Combined heat and power systems offer great potential for increasing the overall efficiency and reliability of power generation, lowering costs, and reducing environmental impact. CHP systems capture waste heat, a byproduct of electricity production, and put it to use for cooling, heating, and humidity control. The section on CHP in this guide discusses the benefits of CHP, CHP system components and technology options, and system integration and sizing options for CHP on college campuses.

Emissions Markets

More and more universities are implementing efforts to reduce their individual contributions to global climate change. The emissions markets section of the guide provides specific strategies for reducing emissions, discusses offsetting emissions through emission credits trading programs, supplies information on national and regional air quality and climate change programs, and provides an overview of world-wide, national and regional greenhouse gas emissions markets and trading programs.
plus a rundown on various fuels and fleet options, including ethanol, Compressed Natural Gas (CNG), biodiesel, liquefied petroleum gas (LPG/ propane), hydrogen, and hybrid and electric vehicles.

Project Financing



- Overview
- Financing Options
- Common Financial Misconceptions
- Case Studies
  - Cape Cod Community College
  - Baylor University
  - University of Michigan
- Resources

Overview

This section defines and explains the specific types of financing mechanisms available for energy efficiency projects, addresses common financial misconceptions, and provides case studies illustrating the various methods of financing.

Public and private capital for energy efficiency improvements can be accessed through a wide and flexible range of financing options, including internal financing, internal revolving funds, debt financing, lease and lease purchase agreements, energy performance contracts, and system benefits funds. (Please see the chart in the Financing Options section that provides an overall comparison of financing options for energy projects.)

With these financing options and the flexibility they offer, no soundly defined energy efficiency project should be discouraged for lack of funds. Financial officers in most organizations are familiar with the basic mechanisms for each of these investment options, which are relatively simple to initiate and implement. Again, it is important to note that these financing mechanisms are not mutually exclusive. Factors such as the type of organization (public or private), size and complexity of the project, internal capital constraints, and in-house expertise will determine the most appropriate set of financing options.

Financing Options

Internal Financing

Internally financed energy efficiency improvements are paid directly with available cash drawn from an organization or building owner's current operating or capital funds. Internal financing is the simplest and most direct way to pay for improvements. One attraction of internal financing is that it allows the organization to retain all energy-cost savings and any benefits from equipment depreciation. It also allows quick project implementation by avoiding contract negotiations or transaction delays often associated with other financing mechanisms. The use of internal financing normally requires the inclusion and approval of energy efficiency projects within an organization's annual operating and capital budget-setting process. However, available internal funds are commonly constrained by budget limitations and competing operating and capital investment needs.

Internal operating funds are most commonly used to finance smaller, short-term projects. These projects often have relatively low capital costs and short payback periods. However, it is important to note that internal funds are commonly tied up and limited by competing budget needs.

Project Financing

Internal Revolving Fund

To capture the profitable returns from energy efficiency investments, some institutions, such as the University of Michigan, have created revolving investment funds. With this revolving fund approach, an initial investment of internal money is made for one or more energy efficiency projects. As savings accrue from avoided energy costs, some or all of the savings are earmarked for repayment to the revolving fund, thus replenishing the initial investment. Any surplus savings in excess of costs are profits that allow the fund to grow even larger. These may be reinvested in additional energy projects. As energy savings compound, so do the returns to the fund and the profits that can be reinvested. Even with small initial capital resources, revolving funds can grow quickly through reinvested revenues.

Debt Financing

Debt financing can be as simple as a loan from a lending institution to a borrower, or as complex as a bond issued and marketed to investors in the open market. Both approaches can be used to finance energy efficiency improvements that are beyond the size and scope of internal financing. Loans are generally used to finance smaller, short-term projects. Bonds may be more appropriate to raise capital for large single projects, or to support a series of smaller projects where the principal amount borrowed is of sufficient size to justify the expense of the bond's issuance and marketing costs.

State and local governments can issue tax-exempt bonds or other debt instruments at substantially lower interest rates than are available to private entities. However, private institutions are eligible for these tax-exempt deals and low interest rates as well with a state or local entity acting on their behalf. For example, Concordia College, a private institution, qualified for a tax-exempt loan to implement an energy efficiency project that included a central chilled water system, various campus efficiency improvements, and the expansion of a music hall. In total, Concordia College borrowed $5,425,000 with a loan term of 15 years. All savings from debt-financed efficiency measures are retained internally.

Debt financing typically works in one of two ways:

1) An organization uses existing or new credit relationships with a financial institution that result in a loan or lease agreement between a single lender and a borrower.
2) Debt is issued in the form of bonds for which capital is raised through individual investors; like stocks, these bonds are tradable in a secondary market.

Lease or Lease-Purchase Agreements

Lease and lease-purchase agreements are contracts that allow the use of equipment for a fixed period in return for a regularly scheduled installment payment. In a lease, energy efficiency is acquired and financed by a third party (the lessor) with little or no up-front cost to a customer (the lessee). Payments made by the lessee to the lessor can be spread over a period of 1 to 15 years or more. Major types of leases include:

- Capital Lease – Capital leases differ from operating leases in that the lessee pays for the equipment and/or improvements in equal monthly installments over the period of the lease. Because of this structure, payments are generally higher than those for an operating lease, but the lessee can purchase the equipment at the end of the lease period for a nominal amount (often $1.00). The lessee is considered the owner of the equipment and can claim tax benefits for equipment depreciation. Unlike an operating lease, a capital lease is considered a form of debt when the lessee is a private individual or organization.

- Guaranteed Savings Leases – A guaranteed savings lease may be either an operating or a capital lease in which the lessee is guaranteed that payments will not exceed energy savings generated by the leased equipment. Payments to the lessor are structured so that if savings are less than those guaranteed, the lessee pays the smaller amount (the amount saved) and receives credit for the difference. Many energy performance contracting agreements are guaranteed savings leases. The next section describes energy performance contracts.

- Operating Lease – In an operating lease, the lessor retains ownership of the equipment. At the close of the lease period, the lessee can re-negotiate and extend the term of the lease, buy the equipment at its residual fair market value, or return the equipment to the lessor. In general, operating leases are only offered if the equipment can be easily moved and redeployed somewhere else.

- Tax-Exempt (or Municipal) Lease / Lease-Purchase – Both operating and capital leases can be made available to tax-exempt entities at significantly lower financing rates than for private-sector borrowers. Since the lessor is not required to pay federal or state taxes on that portion of the lessee's payments that represent interest, a lower rate can be offered than for other types of leases. Tax-Exempt leases were developed as an alternative to procuring equipment by internal or debt financing. Their use has increased significantly in recent years because of their flexibility and a growing need for off-balance sheet financing in response to debt limits. Note that tax-exempt lease purchase rules vary by state. The chart below is an illustrative guide to the tax-exempt lease-purchase financing rules by state.

Lease and lease-purchase arrangements allow building owners of institutions to avoid cash limitations associated with internal financing. Since leasing arrangements can be used for both large and small projects, they provide a flexible instrument for projects of widely varying sizes. Finally, lease financing can often be structured so that payments are considered an operating expense. This means that the value of the lease will not be carried as a debt incurred by an organization.

Project Financing

Tax-Exempt Lease-Purchase Financing by State

(for illustrative purposes)

Source: Environmental Protection Agency

Energy Performance Contracting

An energy saving "performance contract" is an agreement between a building or facility owner and a performance contractor. Energy conservation measures (ECMs) are designed and installed by the contractor who guarantees their performance in return for an agreement, that they can retain a share of the cost-savings derived from these measures over a fixed period of time. A building owner, contractor, or a third party provides financing through one or more of the previously mentioned finance options. Performance contractors provide the option of financing projects, but do not always do so. For example, Baylor University employed a performance contract, but received financing through a university issued, tax-exempt bond.

System Benefits Funds

The availability of system benefits funds, as well as specific programs within the funds, varies by state. Currently, fourteen states have system benefits funds. States such as Michigan, Wisconsin, Oregon, New York and Pennsylvania offer state grants, financial rewards and loans for energy efficiency projects. For example, the New York State Energy Research & Development Authority (NYSERDA) provided $310,000 in incentives under its Distributed Generation/Combined Heat & Power Program towards the combined heat and power project at the State University of New York (SUNY) Buffalo.

Common Financial Misconceptions

Myth: Delaying efficiency projects will save money

Considering the availability of funds, colleges and universities cannot afford to defer the maintenance of aging, inefficient buildings. Measuring the costs of delaying energy efficiency projects adds a new element to the financial decision. Rather than financing the upgrade immediately, university and college managers often reason that postponing the implementation of energy efficiency projects

Comparing Financing Options for Energy Projects

	Internal Funds	Debts (Bonds)	Tax-Exempt Leases	Energy Performance Contracts
Interest Rates	If applicable, flexible and left to the discretion of the institution	Lowest tax-exempt rate	Low tax-exempt rate	Can be taxable or tax-exempt
Financing Term	If applicable, flexible and left to the discretion of the institution	May be 20 years or more	Up to 10 years is common and up to 12-15 years is possible for large projects	Typically up to 10 years, but may be as long as 15 years
Other Costs	N/A	Underwriting, legal opinion, insurance, etc.	None	May have to pay engineering costs if contract not executed
Approval Process	Internal	May have to be approved by voters via referendum	Internal approvals needed. Simple attorney letter required	RFP usually required; internal approvals needed
Approval Time	Current budget period	May be lengthy – process may take over a year	Generally within one week	Generally within 1-2 weeks once the award is made
Funding Flexibility	Varies by institution	Very difficult to go above the dollar ceiling	Can set up a master lease, which allows you to draw down funds as needed	Relatively flexible. An underlying municipal lease is often used
Budget Used	Either	Capital	Operating	Operating
Greatest Benefit	Direct access if included in budget	Low interest rate because it is a general obligation of the public entity	Allows you to buy capital equipment using operating dollars	Provides performance guarantees that help approval process
Greatest Hurdle	Never seems to be enough money available for projects	Very time consuming and energy project not always a priority	Identifying the project to be financed	Identifying the project to be financed, selecting the energy service provider

Source: Environmental Protection Agency

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until budget dollars are available or interest rates are lower is a better financial decision. The common tendency is to avoid interest rates altogether or, at the very least, hold out for out for the lowest possible rate. However, waiting to implement the project also delays the point at which energy savings begin to accrue.

Although it is counter-intuitive to find paying interest a wiser financial decision than paying no interest, in reality, the savings lost from energy efficiency in one year can be greater than the total financing costs over the term of the deal. Of course this is not true for all cases, but university officials should not overlook the costs of delays when making the decision of when and how to finance energy-efficient building improvements.

Myth: Borrowing costs can be taken at face value

In order to get the best deal, the borrower must examine the whole picture in regards to financing energy efficient upgrades. Bonds at 4% interest may seem more appealing than a lease-purchase agreement at 5%. However, to clarify the real savings, net interest costs must be calculated. In general, lease-purchase agreements do not include any extra costs or fees outside the interest rate. The legal opinion for a lease purchase agreement usually requires minimal research and can be provided by internal counsel. However, when dealing with bonds, several extra costs arise that may not be apparent when comparing interest rates.

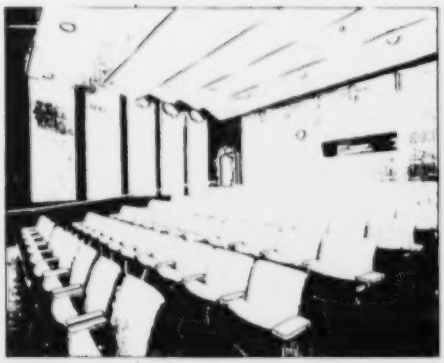
These extra costs associated with bond issuance include compensating underwriters, financial advisors and obtaining legal opinions as well as credit ratings add significantly to the total financial outcome. The comparison of a lease purchase agreement with a bond illustrates that the lowest interest rate does not always guarantee the lowest total borrowing cost. Different financing mechanisms have different fees associated with them. The financing method that produces the lowest total borrowing cost is the best deal, but to select the best deal, the whole financial picture must be taken into account.

Myth: Legal debt is the same as credit-rating debt

Note the importance of the different interpretations of "debt" from three perspectives – legal, credit rating, and accounting. Most lease-purchase agreements are not considered "legal debt." However, credit rating agencies do include some or all of the lease-purchase obligations when they evaluate a public entity's credit rating and its ability to meet payment commitments. These two perspectives (legal and credit rating) may differ a great deal from the way lease-purchase agreements are treated by your accounting department and your organization's external auditors.

Myth: First cost is the only cost

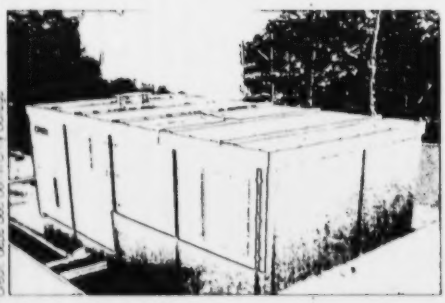
Often only the first cost of energy efficiency equipment is taken into account when implementing energy efficiency upgrades. However, to understand the true cost of equipment, first cost as well as life cycle cost must be considered.



For example, by choosing less expensive lights when implementing an efficiency lighting retrofit, the manager could save money on the first cost. However, the money saved by purchasing the less expensive, lower performance light will be lost to the utility bill. This concept also applies to more complicated equipment such HVAC systems. When financing energy efficiency upgrades, life cycle cost should factor into the decision, just as first cost does.

Project Financing

Case 1: Cape Cod Community College – Tax-exempt Lease Purchase of Fuel Cells



Project Background and Description

In 1998, Cape Cod Community College acquired a fuel cell under the terms of Chapter 25a of the Massachusetts Energy Resource Law, which provides for a Shared Savings Program, otherwise known as performance contracting. NORESCO won the bid as the performance contractor and began by undertaking a campus energy audit. The contractor identified ten energy saving measures, and a fuel cell was one of them. KeySpan Energy, eager to provide the gas for the fuel cell, viewed the installation as a way to gain a foothold in an institution that previously did not use gas. The gas company helped expedite the project, and ran gas lines out to the campus.

Benefits and Costs

The college documented 1.5 million kWh/year in electricity displaced from the campus grid. The fuel cell alone saves $52,000 a year. Using waste heat from the fuel cell to heat the library saves an additional $15,000 in fuel heat. NORESCO guaranteed $182,000 in cost savings a year, and the remaining balance is made up from the other efficiency measures enacted such as a lighting retrofit, premium efficiency motors, variable speed drives in the art building, and hydronic gas-fired heating in the science and art buildings. Calculated emissions savings are 370,000 lbs of CO2.

Project Financing

NORESCO invested $1.3 million. The deal was structured so that NORESCO received payment at the acceptance of the entire energy efficiency project with proceeds from a tax-exempt lease purchase that the college is paying off over a 10-year period.

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Case 2: Baylor University – University Issued Tax Exempt Bond

Project Background and Description

In 1998, Baylor University embarked on a ten-year project in order to upgrade its campus building and utility systems and to prepare the university for anticipated future expansion. This major upgrade included 80 of Baylor's buildings (3.7 million square feet). The university chose Sempra Energy Solutions as their performance contractor. Sempra's role included auditing, engineering/design, construction management, and training. A massive upgrade of Baylor's central heating, cooling, and electrical generation plant was some of the energy conservation measures implemented. Other upgrades included a lighting retrofit, thermal storage, variable speed drives, replacement of a 2,000-ton centrifugal chiller, and automation/control system expansion.

Benefits and Costs

The total project cost was $15 million. The estimated annual energy and water savings were 29,426,185 kWh of electricity, 93,470 mcf of gas, and 4,108 gal of water. In addition, the estimated annual energy cost savings was $1,266,621.

Project Financing

The University issued a tax-exempt bond, with a 10-year contract term running from June 1999 to June 2009.

Contact Information

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Case 3: University of Michigan – Internal Revolving Fund

Project Background and Description

The University of Michigan has made a long-term commitment to bring all campus buildings to ENERGY STAR® standards by 2005. Currently, a total of 56 out of 112 buildings meet the criteria.

Energy efficiency projects have included: energy efficient lighting, HVAC, CH&P, energy audits, Direct Digital Control (DDC), Variable Frequency Drives (VFD), Free Cooling, Variable Air Volume controls (VAV), CO_2 Sensing (uses exhaled Carbon Dioxide as a measure of people occupancy to control fresh air supply to auditoriums), and Occupancy Sensors (control of lighting and air conditioning based on occupancy of space).

Benefits and Costs

In 1997, the University of Michigan staked its internal revolving fund for energy efficiency projects by allocating $2 million of unallocated energy budget funds. Between 1997 and 2003, the university invested a total of $12 million in energy projects.

By 1999, over $600,000accumulated from energy efficiency projects. By 2002, a savings of $6.7 million a year was documented. The projected savings is $9.7 million a year upon full implementation of all ENERGY STAR projects at the end of 2005. Along with financial savings, 590 billion Btu's of electricity and fuel has been saved through 2002 as a result of the efficiency projects.

Project Financing

Internal Revolving Fund

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Resources for Further Information

Environmental Protection Agency:
http://www.epa.gov/EEBUILDINGS/files.cgi/233_what__s_your_share_of_1308.pdf

APPA Facilities Manager Journal:
http://www.appa.org/FacilitiesManager/articleDetail.cfm?itemNumber=210

The Energy Services Coalition:
http://www.escperform.org/about.htm

Office of Energy Efficiency and Renewable Energy:
http://www.eere.energy.gov/buildings/index.cfm?flash=yes
http://www.eere.energy.gov/buildings/highperformance/design_approach.html

Rebuild America:
http://www.rebuild.org/attachments/solutioncenter/financeEE.pdf

CLEAN FUELED

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Overview

College and university campuses around the country are taking a closer look at their behavior and the impact their energy choices have on the local environment as well as the global environment. Campus-operated transportation services offer a number of opportunities for reducing pollutants and greenhouse gas emissions, and also for reducing energy usage. In addition, some colleges and universities—especially state-owned ones—are required by federal, state, or local regulations to adopt certain transportation technologies.

Colleges and universities that want to reduce their emissions have turned to using alternative fuel vehicles and more fuel-efficient motor vehicles in their campus fleets. These vehicles also have the added benefit of reducing reliance on imported oil, a major federal policy objective, and may use fuels produced from local resources, contributing to regional economic development. While alternative fuel vehicles have demonstrated their ability to lower vehicle emissions, their ability to save money for fleets has been less pronounced. Petroleum prices have historically been very competitive with prices for alternative transportation fuels and have thus limited demand for these other fuels. Recent petroleum price increases have made some alternative fuels more competitive but in some cases these other fuels also have become more expensive. Fleets interested in using alternative fuels should learn more about local prices for alternative fuels and explore opportunities for locking in lower prices with longer-term contracts. Fleets also should be aggressive in seeking funding assistance and partnering with other fleets interested in alternative fuels. Fleet managers making purchasing decisions for 'greener' vehicles need also explore federal, state, and local laws and incentives that might help sway their decision in today's fluctuating economy. See www.fleets.doe.gov for a full range of information of available vehicles, vehicle comparisons, fuel cost analysis tools, laws and incentives, and much more.

This section discusses the benefits of some of today's most accessible clean, alternative transportation fuels, and addresses hydrogen, a fuel that could one day become the dominant transportation and energy source fuel. This section also describes some schools that have had significant success in transforming their fleets to be cleaner, more fuel-efficient fleets.

The Department of Energy (DOE) is helping to educate college and university campuses on the benefits of using alternative fuel vehicles and also on how to obtain funding for their fleets. Check out the Partnership Opportunities with the Clean Cities Program. DOE's Alternative Fuel Data Center, managed by the National Renewable Energy Laboratory, is a great source of information on different transportation fuel options, vehicle technologies consumer and fleet buyer information, and frequently asked questions. The end of this section provides information on how to find out more about DOE's Clean Cities and alternative fuel vehicle programs.

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Clean Fuel Fleets

Biodiesel

Made by transforming animal fat or vegetable oil with alcohol, biodiesel can be directly substituted for diesel either as neat fuel (B100) or as an oxygenate additive (typically in blends of 20% biofuel and 80% diesel, called B20). The use of B100, and most blends above B20, may require special consideration for use. Before using more concentrated blends of biodiesel, fleet managers should check with the engine manufacturer to ensure that the use is permitted and that warranties will not be affected. Fleets subject to the Energy Policy Act of 1992's fleet programs can earn credits by using B20. B20 is the only fuel recognized by the Energy Policy Act that does not require purchase of new vehicles. Important additional markets for biodiesel include city transit buses and school buses, where biodiesel helps offset particulate and toxic emissions. In Europe, the largest producer and user of biodiesel, the fuel is usually made from canola oil. In the United States, the second largest producer and user of biodiesel, the fuel is usually made from soybean oil or recycled restaurant grease.

Biodiesel popularity is growing rapidly, with U.S. sales increasing from about 7 million gallons in 2000 to more than 20 million gallons in 2001. The interest in this fuel is due to the fact that it is renewable and generally cleaner than diesel fuel for which it is both a substitute (B100) and an additive (B20). Both soybean oil and recycled restaurant cooking oil are in surplus and biodiesel production uses only a small portion of each, so there is currently no resource constraint. (Because of incentives from a U.S. Department of Agriculture program supporting commodity purchases for increased biofuel production, 2001 biodiesel production was predominantly from soybean oil, but production from recycled cooking oil is expected to match soybean oil once the effect of that program is over.) In 2001, production was near capacity for dedicated biodiesel producers, but most producers are expanding their production capacity and the detergent and fatty acid industries have the capability of providing another 30 to 50 million gallons of capacity annually, if needed to meet demand.

Because it is oxygenated, biodiesel dramatically reduces air toxins, carbon monoxide, soot, small particles, and hydrocarbon emissions by 50% or more, reducing the cancer-risk contribution of diesel up to 90% with pure biodiesel. Air quality benefits are roughly proportional for diesel/biodiesel mixtures; however, emissions of nitrogen oxides increase at levels over 20%. Recent studies prepared for the National Renewable Energy Laboratory (NREL) show that B20 mixtures lower particulate matter emissions and have a negligible impact on ozone formation.

The most common use of biodiesel—B20—requires no engine modifications. Because biodiesel is a mild solvent, it may loosen deposits in the fuel system left behind by diesel, clogging fuel filters. Fleets experiencing this problem adopt the practice of more frequently changing out their fuel filters. Because it gels

at higher temperatures compared to petroleum diesel, pure biodiesel (B100) requires special fueling and storage practices in cold climates. Also, when using pure biodiesel, replace rubber seals, gaskets, and hoses made before 1994. Engine manufacturers' warranties vary with regard to biodiesel use, so contact engine manufacturers. Biodiesel contains slightly less energy than petroleum diesel, so fuel economy tends to fall 7% for every 10% of biodiesel in your fuel blend. For fuel characteristics of alternative fuels, gasoline and diesel, refer to http://www.afdc.doe.gov/fuel_comp.html.

Cost Considerations:

While the cost of producing biodiesel varies greatly with feedstock and production facility size, market analysis suggests that it should cost about $2.50 per gallon now, dropping to $1.50 per gallon with large-scale commercial production. Prices for soybeans and recycled cooking oil in 2001, however, were already at the $1.50 per gallon level. While biodiesel is more expensive than petroleum diesel, B20 generally only costs 8 to 20 cents per gallon more than regular diesel and doesn't involve any significant new infrastructure costs.

Compressed Natural Gas (CNG)

Natural gas vehicles, including vans, trucks, and passenger cars, are available from major automobile manufacturers like GM, Ford, and Honda. Major truck and bus manufacturers, as well as heavy-duty engine manufacturers, offer a variety of natural gas products. Some specialty manufacturers also offer forklifts and off-road vehicles fueled by natural gas. Original Equipment Manufactures (OEMs) offer standard factory service and warranties for their NGV products. Natural gas powered vehicles are available as dedicated, bi-fuel or dual-fuel options. Dedicated vehicles only operate on natural gas, while bi-fuel vehicles operate on natural gas and gasoline. Dual-fuel CNG vehicles use a small amount of diesel fuel for ignition but operate mostly on natural gas.

In general, dedicated natural gas vehicles demonstrate better vehicle performance and lower emissions than bi-fuel or dual-fuel vehicles because their engines are optimized to run on natural gas. In addition, dedicated vehicles do not have to be equipped with two fuel systems, as is the case with bi-fuel and dual-fuel vehicles, thereby increasing cargo capacity and reducing weight.

The primary benefit of using natural gas is its ability to reduce criteria pollutants. Light and heavy-duty natural gas vehicles have demonstrated that they can meet extremely demanding emission levels. Although it is not a renewable fuel, except when produced from landfill gas, natural gas is promoted as a domestic alternative to foreign oil because most of the natural gas used in the U.S. is domestically produced or comes from Canada.

Clean Fuel Fleets

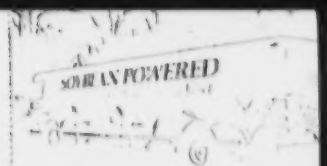
Cost Considerations:

Several issues should be taken into consideration when evaluating fleet options, including required infrastructure, fuel and vehicle costs, reduced maintenance requirements, and available financial incentives. CNG prices have historically been about 25-50% lower than gasoline or diesel fuel prices, but vary greatly on a regional basis. In some cases recent prices of CNG have been higher than gasoline and diesel prices but customers with long-term contracts are somewhat shielded from price swings. A lower price for CNG helps offset the higher initial cost of the vehicle. It has been shown that certain NGV maintenance costs are also lower--for instance, oil change periods can be extended and engine wear is reduced. The combination of lower fuel and maintenance costs can provide a relatively short payback period for high-fuel-use fleet operators. Depending on the number and size of onboard storage tanks, mileage between fill-ups can be comparable to gasoline or diesel fueled vehicles. Range should not be an issue unless fleet vehicles leave the university grounds for extended periods of time without access to fueling. Visit http://www.afdc.doe.gov/refueling_mapsite.shtml to view nationwide locations of refueling stations.

Ethanol

Ethanol is the top selling non-petroleum motor fuel in the U.S. One out of every eight gallons of gasoline sold in the United States now contains about 10% ethanol. Ethanol, also known as ethyl alcohol or grain alcohol, is most commonly used as a gasoline additive. A less common but growing use of ethanol is as a motor fuel for flexible fueled vehicles. This form of ethanol is known as E85 and consists of 85 % ethanol and 15 % gasoline. The 15% gasoline blend has been found to eliminate engine-starting problems, especially in colder climates. E85 is recognized by the federal Energy Policy Act as an alternative fuel and DOE is actively promoting its use as a petroleum alternative. Ethanol from grain (chiefly the starch in kernels of field corn) is the primary means of current ethanol production in the United States. The primary societal advantages of ethanol are that it is renewable and its use, both as an additive and as a dedicated alternative fuel, lowers vehicle emissions. In many areas, interest in ethanol is driven by economic opportunities for the local agricultural community.

Many universities already have vehicles in their fleets that can use E85. Vehicles that can use either gasoline, E85, or a mixture of the two, known as "flexible fuel vehicles," are sold as standard models by the major manufacturers. For example, the Chrysler Voyager, Dodge Caravan, and Ford Taurus are just a few of the vehicles sold standard as FFVs. These vehicles require only minor modifications, including redesigned oxygen sensors and different seals in the fuel system. As a result, E85 vehicles cost about the same as or only a little more than comparable gasoline powered vehicles. Most manufacturers of E85 FFVs offer them at same price as the comparable gasoline model. Because ethanol contains about one-third less energy per gallon than gasoline, E85 vehicles will see somewhat reduced fuel economy. Ethanol infrastructure also is relatively affordable compared with other alternative fuel options. A single tank and fueling dispenser installed at a site may cost as little as $30,000.



Cost Considerations:

Federal and state subsidies have helped to keep ethanol fuel prices competitive with petroleum prices. Ethanol made from corn, as of 2001, sold for around $1.20 to $1.50 per gallon. This makes the cost of ethanol comparable to that of gasoline and petroleum-derived gasoline additives. In addition to the federal excise tax exemption, which has been in place since 1979, 16 states (AK, CT, HI, ID, IL, IA, KS, MN, MO, MT, NE, ND, OK, SD, WI, WY) now also provide excise tax exemptions or producer credits for ethanol. There's currently a small but growing network of E85 stations. As of 2003, there are about 165 E85 stations nationally, of which almost ½ are in Minnesota, the rest being predominantly spread among the corn-producing states. Colleges and universities can help be a catalyst in the community for bringing in E85 infrastructure, which would benefit other fleets in the area and perhaps share costs.

Hybrid-Electric Vehicles and Electric Vehicles

Both Hybrid-electric (HEV) and Electric vehicles (EV) are available on the market today in certain models, and both reduce emissions and reduce the use of imported oil. Electric vehicles have zero end-use emissions, and can be smart choices for smaller vehicles and where there is a strong desire to reduce air pollution from vehicles. Electric vehicles can also be powered from renewable resources if the powering station is fueled by wind, photovoltaics, or hydro. Electric vehicles are a good option for small patrolling vehicles, especially for the campus security department or local police department. The small vehicles are agile, often able to work in spaces too small for traditional patrolling vehicles, reliable, and easily recharged.

Hybrid electric vehicles increasingly are becoming popular with the public. These vehicles, now available in sedan models from Toyota and Honda, and soon to be from other manufacturers, thus far are gasoline hybrids that offer a number of advantages relative to conventionally fueled vehicles, including lower pollution (especially greenhouse gas emissions) and substantially increased fuel economy.

The University of Nevada, Las Vegas purchased the Gem vehicle for police patrol activities but now uses it to shuttle dignitaries and to aid other campus activities. The electric vehicle manufactured by Chrysler drew too much public attention during patrols, removing the anonymity officers prefer when making rounds. The vehicle went from purely functional to showcasing UNLV's concern for the environment.

Cost Considerations:

Electric and hybrid electric vehicles are relatively expensive compared to similar gasoline powered vehicles. (Hybrids in some states are not necessarily more expensive after the incentives are applied.) Some electric vehicles, however, can save fleets money if they replace larger gasoline vehicles that are not necessary

for the desired workload. In the case of electric vehicles, infrastructure must be installed to allow recharging of the vehicles. Hybrid electric vehicles powered by gasoline engines do not require any additional refueling infrastructure. Cost savings will depend on electricity costs for electric vehicles and on the total amount of fuel displaced by hybrid electric vehicles.

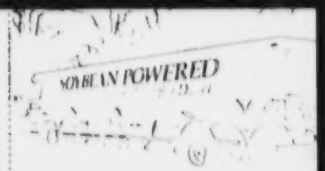
Hydrogen

Hydrogen (H_2) will play an important role in developing sustainable transportation in the United States, because in the future it may be produced in virtually unlimited quantities using renewable resources. Hydrogen can also be reformed from natural gas, ethanol, methanol, and LPG or generated from other sources of electricity used to split hydrogen from water. Hydrogen can be used to run fuel cells in vehicles or can be the fuel source for an internal combustion engine. In a fuel cell, hydrogen and oxygen are fed into a proton exchange membrane (PEM) or other type of fuel cell "stack," producing enough electricity to power an electric automobile, without producing harmful emissions. Hydrogen has been used effectively in a number of internal combustion engine vehicles as pure hydrogen mixed with natural gas (Hythane®), and in a growing number of demonstration fuel cell vehicles.

There are an increasing number of hydrogen vehicle demonstration projects around the U.S. funded by federal, state, and private sources. President George W. Bush has proposed an initiative to spend $1.3 billion on hydrogen-powered car research over the next five years. Under the President's hydrogen fuel initiative, the first car driven by a child born today could be powered by fuel cells. The hydrogen fuel initiative complements the President's existing FreedomCAR initiative, which is developing technologies needed for mass production of safe and affordable hydrogen-powered fuel cell vehicles. Through partnerships with the private sector, the hydrogen fuel initiative, if passed, and FreedomCAR will make it practical and cost-effective for large numbers of Americans to choose to use clean, hydrogen fuel cell vehicles by 2020. This will dramatically improve America's energy security by significantly reducing the need for imported oil, as well as help clean our air and reduce greenhouse gas emissions. It is estimated that in approximately 10-20 years hydrogen vehicles, and the infrastructure to support them, will start to make an impact. Of course, fuel cells and hydrogen fuel for vehicles represent new challenges, but the government and industry are working to overcome technical and cost barriers.

Cost Considerations:

Hydrogen vehicles are currently only available as demonstration, prototype vehicles. Their cost is extremely high. These vehicles will not be available for a number of years. Some fleets may find opportunities to introduce these vehicles into their fleets earlier if they are part of demonstration projects.



Liquefied Petroleum Gas (LPG/Propane)

Propane is produced as a by-product of natural gas processing and crude oil refining, and is a popular alternative fuel choice because an infrastructure of pipelines, processing facilities, and storage already exists for its efficient distribution. Besides being readily available to the general public, Liquid Petroleum Gas (LPG) produces fewer vehicle emissions than regular gasoline. Tests conducted by the U.S. Environmental Protection Agency show that propane vehicles can produce 30 – 90% less carbon monoxide than gasoline engines and about 50% fewer toxins and other smog-producing emissions.

More than 350,000 vehicles, mostly in fleets, are traveling the nation's highways under propane power. Propane is powering taxis in Las Vegas; school buses in Kansas City and Portland, Oregon; sheriff and police cars in other communities; and hundreds of fleet vehicles around California. Propane is used in both light- and medium-duty vehicles. Estimates have placed the number of registered propane-powered vehicles in California as high as 40,000. Propane has been used as a transportation fuel around the world for more than 60 years.

Vehicles fueled with propane often need less frequent servicing. According to the Propane Education and Research Council, some operators report vehicle service lives that are two to three years longer than the average gasoline vehicle. Operators also report extended intervals between required maintenance, though this is not necessarily recommended.

Existing service station infrastructure used for conventional fuels can be modified to dispense propane. The additional costs of adapting a station for propane use is low compared to the requirements for other alternative fuels. There are more than 3,400 propane-fueling stations across the country. This number greatly exceeds all other alternative fuels.

Cost Considerations:

LPG transportation fuel is generally competitively priced relative to gasoline (80 to 95 cents per gallon, amounting to a gasoline equivalent price of $1.10 to $1.31 per gallon), but a wider variation in price can be experienced depending upon the pricing practices of the local station operator. Most fleet purchasers of propane are able to negotiate better pricing from the LPG supplier, sometimes as low as 60 cents per gallon for wholesale. Propane transportation fuel is subject to taxes - 8.3 cents per gallon federal excise tax, 6 cents per gallon state excise tax, and state sales taxes on the bulk purchase of the fuel.

Campus Planning

Another option available for colleges and universities looking to reduce emissions and limit vehicular traffic on campus is to reduce the number of vehicle miles

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Clean Fuel Fleets

traveled. Since most vehicle miles are used for commuting and for running errands, proper urban planning—for instance, with centrally located services and a good public transportation system—can minimize or eliminate the need to use a vehicle. One way to reduce vehicle miles is to encourage alternative modes of travel instead of using fleet vehicles, including biking and walking. Bike paths and pedestrian paths are essential components of encouraging alternative transportation. Electric bikes are an alternative to using fleet vehicles for short trips for one or two people.

Regulations

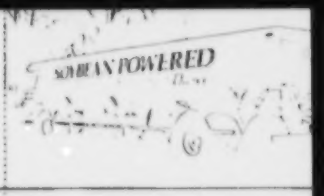
State colleges and university systems, according to DOE, are generally considered to be state agencies. The federal Energy Policy Act (EPAct) requires that certain covered fleets, including state government agencies, need to acquire alternative fuel vehicles (AFV), in specified percentages of new vehicle purchases. DOE has issued final regulations implementing the EPAct AFV requirements as part of its Alternative Fuel Transportation Program. State government fleets are required to file an annual report with DOE that includes the number, type, and location of the AFVs they operate. Section 512 of EPAct establishes penalties for non-compliance with these provisions. DOE has guidance materials to aid fleets in understanding the regulations, available at www.ott.doe.gov/epact/state_fleets.shtml.

The light duty vehicles of state colleges and universities are potentially subject to the regulations in the Alternative Fuel Transportation Program if they meet the following additional criteria: being located in a metropolitan statistical area with a population of 250,000 or more (according to the 1980 census), and having a light duty fleet of at least 50 vehicles, of which 20 or more are centrally fueled or capable of centrally fueling. Based on the large size of many university fleets and their location near major population centers, DOE believes that a number of university or college operated fleets are covered by its regulations. For more details, see http://www.afdc.doe.gov/pdfs/bluebook.pdf.

Partnership Opportunities

DOE's Clean Cities Program supports public and private partnerships that deploy alternative fuel vehicles and build supporting infrastructure. The mission of the Clean Cities Program is to enhance our nation's energy security and air quality by supporting public and private partnerships that deploy clean-burning AFVs and build their associated fueling infrastructure. Coalitions have been formed in 80 communities or regions across the nation, and universities and colleges are often key members of coalitions.

Clean Cities takes a unique, voluntary approach to AFV development, working with coalitions of local stakeholders to help develop the AFV industry. The program builds on strong local initiatives and a flexible approach to building alternative fuels markets, providing participants with options to address problems unique to their cities and fostering partnerships to help overcome them.



Clean Cities focuses its efforts on niche markets where AFVs make sense and have the most impact. An example of an appropriate niche is a high-mileage, centrally located fleet. High-mileage fleets consume larger quantities of fuel, so over time, fleet managers/facilities enjoy the cost savings associated with less expensive alternative fuels. The niche market approach is a strategy based on a sound and sustainable infrastructure plan, rather than one based primarily on the acquisition of vehicles in a region. Although both are equally important, this represents an important shift in the strategic mindset of alternative fuel marketing, one that is critical to long-term success. With the many niche markets in communities across the country—taxis, delivery fleets, shuttle service and transit bus fleets, airport ground fleets, school bus fleets, and national park vehicles—market penetration for alternative fuels and vehicles can make a big difference.

Financing/Funding Sources and Options

A wide variety of funding sources are available for alternative fuel activities. In addition to seeking conventional funding sources, it is important to explore opportunities unique to your area and to link with diverse partners. Check out metropolitan planning organizations, research councils, vehicle dealerships, and other entities that will support alternative fuel fleet financing. Participating in a local Clean Cities coalition can help provide you with information and access to these resources. Find out the location of the nearest coalition and a list of funding and support opportunities at www.ccities.doe.gov.

State Funding Sources:

State Energy Program grants fund acquiring commercially available AFVs, including school buses and AFV infrastructure. Grants also provide cost sharing toward projects that support Clean Cities coalition activities. Contact your state energy office for specific rules and guidelines. A funding section on the Clean Cities Web site is available at: http://www.ccities.doe.gov/support.shtml.

Congestion Mitigation and Air Quality (CMAQ):

Congestion Mitigation and Air Quality (CMAQ), funded by the Federal Highway Administration and the Federal Transit Administration, is another funding opportunity available through the federal government. This program provides funding for switching transit vehicles to alternative fuel vehicles, purchasing vehicles, and fueling equipment for other public agencies and private companies. CMAQ requires that the "alternative fuel" chosen must reduce emissions to be eligible. Funds are available for a wide range of government and nonprofit organizations, as well as private entities contributing to public/private partnerships. The process for obtaining CMAQ funds varies as Metropolitan Planning Organizations and state Departments Of Transportation (DOT) manage the funds. Colleges and universities need to work with Metropolitan Planning Organizations to explore potential CMAQ funding. More information is available from the Federal Highway Administration website: www.fhwa.dot.gov/environment/cmaqpgs/index.htm.

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Clean Fuel Fleets

Case 1: Emory University Alternative Transportation Program

Project Background and Description

Without a state mandate or university directive, Emory University incorporates CNG shuttles and buses and electric vehicles into its campus fleet. Alternative fuel vehicles (AFVs) within the fleet include 20 CNG buses (total 34) used for shuttling purposes, 5 CNG vans for housing, 5 electric pick-up trucks for grounds maintenance, and 20 electric carts for various applications.

The CNG vehicles refuel off campus at a nearby station operated by Metropolitan Atlanta Rapid Transit Authority (MARTA). A grant-approved on-site station is to be installed to alleviate time and proximity issues related to refueling off campus.

The university has implemented into its Parking Rules and Regulations policy a restricted access road for AFV use only, providing a built-in incentive to purchase AFVs exclusively as the fleet expands or is upgraded.

Project Financing

An on-site grant-funded station is to be installed in the near future. In 2000, the school received a $225,000 DOE grant for dedicated charging stations in the recently opened parking structure. Ford Motor Co. provided rebates on their vehicles.

Energy Savings/Environmental Benefits

Standard emissions reductions apply with the CNG vehicles, although they have not quantified that data. The school also provides incentives not to drive, with ride-sharing, free shuttle passes for eligible employees, and bicycle and walking programs.

Costs and Cost Savings

Brian Shaw, Director of Alternative Transportation, reports that the life-cycle costs for CNG buses are comparably lower than with standard fleets. The greater up-front costs are offset by lower fuel costs. Mr. Shaw reports that the cost, on average, is $0.75/gallon of CNG versus $1.40/gallon of standard diesel.

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SOYBEAN POWERED

Case 2: UCLA Transportation Services

Project Background and Description

The UCLA Transportation Services fleet numbers over 800 vehicles, nearly half of which are AFV. In 2003, the school received a donation of 127 Global Electric Motorcars (GEMs) from Daimler Chrysler, greatly enhancing the capabilities and efficiency of the facilities, housing, security, and community safety programs.

GEMs are street legal in posted areas up to 35 mph with a top speed of 25 mph, and they plug into any standard outlet for recharging. Maintenance costs are low, as reported by the university, and ease-of-use makes the campus more accessible. Traffic around the campus has historically been a deterrent to efficiency, an issue alleviated by the use of GEMs. The preclusion of dedicated chargers is an additional benefit.

The university owns, funds, and maintains its own fleet, with Advanced Service Excellence (ASE) certified technicians on-site. In addition to the GEMs, the school maintains an on-site CNG fueling station for 20 vans, 17 buses, 10 cars, and 10 bi-fuel CNG/gas Ford Contours. A second, slow fill station, for overnight refueling, is planned for the bus fleet. This will alleviate congestion at the present station. Six hybrid Toyota Prius are also among the AFV fleet.

Environmental Benefits

Emissions intensity is greatly reduced by the use of zero emission vehicles such as the GEMs. However, actual overall UCLA fleet output has not been affected greatly, CNG vehicles notwithstanding. The fleet has not been diminished by the addition of the GEMs. No vehicles have been retired as a result of their addition. The GEMs emit no regulated chemicals and therefore qualify for emissions credits, which Daimler Chrysler claims, as part of the initial agreement.

Costs and Cost Savings

The donation of the vehicles is the retail equivalent of $1.2 million.

Preventive maintenance costs on the GEMs is $35/month, which requires checking and filling water in the batteries. Because of the limited possibilities for off-campus use, personal use of university vehicles has been curbed, which acts as a peripheral fuel usage cost savings. Without the need for a central dedicated charging location, the GEMs can be stored at the locations they serve (e.g., facilities, housing, security) provided there is a charging station at that location.

The university reports that overall maintenance of CNG vehicles is lower than that of petroleum powered vehicles, with lower fuel costs compounding the savings.

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Case 3: Pennsylvania State University Hydrogen Program

Project Background and Description
In partnership with Centre Area Transit Authority (CATA), Air Products and Chemicals, Inc., Collier Technologies, the Pennsylvania Department of Environmental Protection (PDEP), and the U.S. Department of Energy (DOE), Penn State is committing to retrofit its transportation fleet with hydrogen and hybrid CNG/hydrogen engines to study the feasibility of hydrogen as the fuel of the future. Three buses and eight light duty vans will operate on a blend of hydrogen and natural gas, and one internal combustion engine (ICE) powered car will be converted to 100% hydrogen. A refueling station is to be installed prior to the vehicle rollout as a separate project.

Project Financing
The project will be cost shared by several parties. Air Products, CATA, PDEP, and the University are partnering to apply for funding from various sources, including DOE. The Department of Energy and Air Products are funding the fueling station. The overall cost is estimated, over four years, at $2.5 million for the fleet study.

Energy Savings
Each vehicle will be equipped with monitoring devices to track long-term data. It is known, however, that the only byproduct of hydrogen combustion is water.

Environmental Benefits
The fuel itself emits no harmful chemicals.

Costs and Cost Savings
The costs are estimated at $2.5 million for the duration of the fleet project. As a feasibility study, savings are not a focus of this study.

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Case 4: Harvard University Green Campus Initiative

Project Background and Description

As part of its Green Campus Initiative, Harvard is instituting and testing biodiesel and CNG programs. Each program is a study on the feasibility and environmental benefits of lower emission vehicles.

The biodiesel program is a two-year study overseen by David Harris, General Manager of Transportation Services. With no requisite retrofit, all post-1996 diesel vehicles are fueled with a biodiesel blend (B20). The university will install and operate a biodiesel tank.

Project Financing

This project is financed by the University through the Harvard Green Campus Initiative.

Energy Savings/Environmental Benefits

B100 emits 70% fewer greenhouse gases (GHG) and 45% less carbon monoxide than its conventional diesel counterpart. The university will be using B20, which has comparable environmental benefits.

Costs and Cost Savings

The only costs incurred are for the biodiesel fuel and the fuel tank. The fuel tank cost approximinately $40,000. No retrofit is necessary on any post-1996 diesel vehicle. The University is currently negotiating contracts for fuel vendors and expects, because of competition between vendors, to lock in substantial savings. The university reports that maintenance costs are lowered and that "well to wheel" costs and impacts ultimately favor biodiesel.

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Resources for Further Information

Ag Processing, Inc, Partners in Food Production:
http://www.agp.com

Alternative Fuels Data Center:
http://www.afdc.doe.gov

DOE's Buyer's Guide for Vehicles:
http://www.ccities.doe.gov/vbg
See this site for AFV and advanced vehicle technologies, refueling site information, laws and incentives, and much more

DOE's Clean Cities Program:
http://www.ccities.doe.gov/

DOE's Office of EERE. State Energy Alternatives:
http://www.eere.energy.gov/ state_energy/

DOE's Office of EERE. Transportation-Air Emissions and Standards:
http://www.eere.energy.gov/EE/trans_air_emissions.html

DOE's Office of EERE. Transportation-Reducing Vehicle Miles Traveled:
http://www.eere.energy.gov/EE/trans_reducing_miles.html

Electric Drive Transportation Authority:
http://www.electricdrive.org

Energy International's CNG Station Guide:
http://www.energyint.com/cng_station/index.htm

National Biodiesel Board:
http://www.biodiesel.org

National Ethanol Vehicle Coalition:
http://www.e85fuel.com

Natural Gas Vehicle Coalition:
http://www.ngvc.org

Resource Guide: Infrastructure for Alternative Fuel Vehicles:
http://www.energy.ca.gov/reports/afvguide.html

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Combined Heat and Power

- Overview
- Benefits of CHP
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- System Integration & Sizing Options
- Cost Effectiveness
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Overview

Combined heat and power (CHP) has a long history in the United States as an efficient means of producing electricity and heat from the same power source. At the turn of the 20th century, CHP systems were the most widely used electricity generators in the United States, providing heat and power to localized districts and industry. As technology advanced and reduced transmission power losses, power plants became larger and were located farther from urban centers. This, coupled with improved reliability of the electrical grid and lower costs, led to increasingly separate power and heating industries. However, as energy prices rose during the energy crises of the 1970s, combined heat and power once again became a viable option. Over the years, with advances in research and technology developments, CHP has evolved into an even more efficient, cost-effective means for providing power and thermal needs to buildings and industry. College and universities are ideal candidates for combined heat and power systems because the systems can be housed on or near campus to distribute energy to a network of campus facilities.

Combined heat and power systems offer great potential for increasing the overall efficiency and reliability of power generation, lowering costs, and protecting the environment. In conventional power generation facilities, electricity is generated and waste heat is exhausted either into the air or water streams. In fact, roughly two-thirds of all the fuel used to generate electricity in the United States is wasted by venting this unused thermal energy.[1] Combined heat and power (CHP) systems capture that waste heat, a byproduct of electricity production, and put it to use for cooling, heating, and humidity control systems. This section addresses the benefits of CHP, CHP system components and technology options, CHP system integration and sizing for college campuses, and CHP cost-effectiveness. The section also presents several case studies.

Benefits

Combined heat and power offers many benefits for colleges and universities, among them reduced energy and life cycle costs, improved power reliability, and improved environmental quality.

Reduced Energy and Life-Cycle Costs

Energy cost savings from CHP systems are due to increased energy efficiency and reduced power demand charge. Compared to conventional stand-alone systems in which power is generated in a separate system from heating, cooling, and humidity control, combined heat and power systems use significantly less energy. Conventional systems with separate electricity and heat generation facilities require 65% more energy than integrated heat and power systems, as shown in the accompanying diagram.

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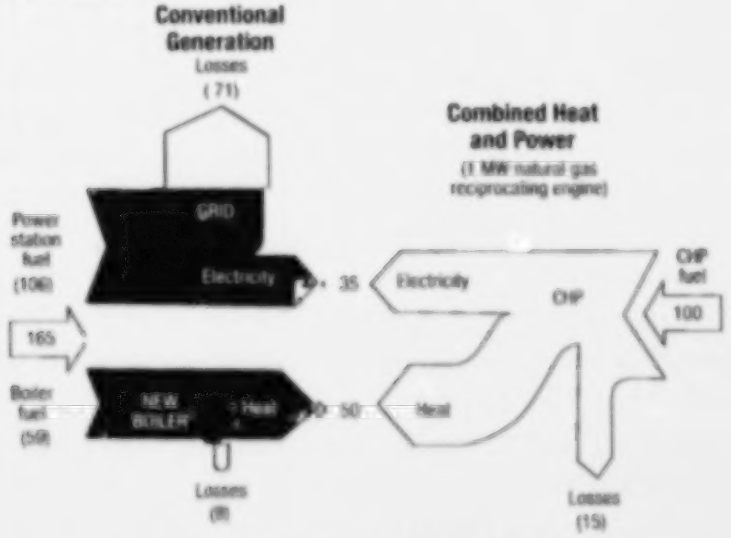
Combined Heat and Power

Efficiency Comparison of Conventional Generation vs. Combined Heat and Power



Source: Cooling, Heating, and Power for Building — http://www.bchp.org

Although the initial cost of installing a CHP system may be higher than the cost of purchasing electricity and using conventional chillers and boilers for humidity control, heating and cooling needs, the cost over the lifetime of the CHP system is often lower due to increased energy efficiency and associated energy savings.

CHP systems reduce power demand by generating a portion of campus power needs on site, and by using thermal energy from power generation equipment, instead of electricity, for operating cooling, heating, and/or humidity control equipment. Finally, by avoiding the need to purchase electricity during costly peak periods from the local utility, colleges and universities with CHP systems save on their energy bills by having an onsite power generation facility.

Improved Power Reliability

Combined heat and power systems can improve power reliability by reducing campus dependence on the electric power grid since power is generated on-site or near-site. Power outages due to loss of distribution lines, therefore, can be reduced with CHP systems located at or near buildings on college campuses. The reduced demand on the local utility also improves grid reliability, especially in areas in which the grid is at or near capacity.

Protecting the Environment

Because CHP systems are highly efficient, generating both electricity and thermal energy from the same fuel source, they require less fuel to operate than

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conventional power plants, chillers and boilers. This reduction in fossil fuel use results in significant reductions in greenhouse gas and air quality emissions. The reduction of fossil fuel consumed per unit of energy used in CHP systems results in a 45% reduction in air emissions compared to conventional centralized power plants.[2] Rutgers University's combined heat and power plant, for example, saves 130 million standard cubic feet of natural gas and 470 barrels of oil annually compared to conventional separate heat and power, thereby eliminating 7,600 tons of CO2 emissions each year. NOx emissions have been reduced by 66% (150 tons per year).[3] NOx and CO2 emission rates for various power production technologies are shown in the chart below.

NOx and CO_2 Emissions for CHP Power Production Technologies

Note: Nationwide utility averages for emissions from generating plants are 0.0045 lb/kWh of NOx, and 1.32 lb/kWh of CO_2

Technology	NOx Emissions (lb / kWh)	CO_2 Emissions (lb / kWh)
Diesel Engine	0.017	1.7
Natural Gas Engine	0.0059	0.97
Dual Fuel Engine	0.01	1.2
Microturbine	0.00049	1.19
Combustion Turbine	0.0012	1.15
Fuel Cell	0.000015	0.85

Source: Laboratories for the 21st Century Best Practices

Combined heat and power is also a cost-effective way of improving indoor air quality. Effective humidity control within buildings is essential for preventing the growth of mold, mildew, bacteria, and microorganisms that can pose serious indoor air quality and related human health concerns. Integrating desiccant dehumidification in CHP systems provides a much more energy efficient means for humidity control than conventional systems. Conventional chillers must lower the temperature of incoming air to below the dew point temperature, condense out the moisture, and usually must reheat the air to bring it back to a comfortable temperature. This is different from desiccant systems, which use available thermal energy to remove moisture from the air. Overcool and reheat is significantly more energy intensive than desiccant dehumidification, particularly when electricity is used for the reheat.

System Components

Combined heat and power systems are comprised, essentially, of three components: a power generator, a heat recovery system, and a thermally activated machine(s). A CHP system may also include electrical equipment driven by the on-site power generator. In some cases, a combination of thermally activated and electrical equipment may make sense or may be the only feasible option due to a limited availability of waste heat or its incompatible quality.

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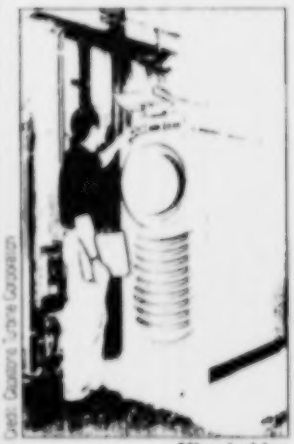
Combined Heat and Power

Electrical power can be generated using internal combustion engines, combustion turbines, microturbines, or fuel cells. Heat is recovered from the exhaust gases and/or waste heat from the power generator, which can then be used by thermally activated machines for heating, cooling, and controlling humidity in buildings. Researchers are currently advancing development of "ready to go" modular packaged CHP for smaller systems, which have great potential for reducing overall costs and improving energy efficiency.

Power Generation

One option for producing power in a combined heat and power system suitable for college and university campuses is an internal combustion engine. These engines use either natural gas or propane to produce mechanical shaft power that can be used to operate a generator to produce electric power. The shaft power can also be used to operate other equipment, such as a refrigerant compressor for process or space cooling.[4] This type of chiller is similar to a conventional electric chiller, except that a gas engine as opposed to an electric motor drives the refrigerant compressor. Internal combustion engines range in capacities of 5 kilowatts (kW) to 10 megawatts (MW), and operate at approximately 30-35% power generation efficiency (not accounting for the added efficiency of utilizing thermal energy for heating, cooling, and humidity control).


Microturbine

Combustion turbines are another option for power production. Combustion turbines use natural gas or fuel oil to produce high-temperature, high-pressure gas to induce shaft rotation. Some turbines also use a recuperator (a type of heat exchanger) for capturing the thermal energy from the turbine's exhaust heat. This thermal energy can then be used to preheat the air/fuel mixture for the combustion process, thereby significantly enhancing efficiency. Combustion turbines range in size from 400kW to more than 100MW, and operate at power generation efficiency of 25 to 35% (excluding added CHP efficiencies).[5]

Microturbines are the newer generation of smaller turbines, with capacities of less than 400 kW. Some have capacities as low as 25kW to 100kW. Microturbines can use natural gas, propane, landfill gas, and gases from sewage treatment and animal waste processing facilities. Because microturbines have far fewer moving parts, they can significantly reduce operation and maintenance costs. By utilizing recuperators, microturbines can operate at approximately 25% to 30% power generation efficiency not including parasitic electrical energy use.[6]

An emerging technology that has great potential for CHP application is the fuel cell. A hydrogen fuel cell produces electric power without combustion through electrochemical reactions between hydrogen and oxygen. Because heat is also produced, it is a prime candidate for CHP. Fuel cells have no moving parts, so they have no mechanical inefficiencies and are potentially low maintenance. Most fuel cells today use natural gas as the source of hydrogen.[7] Phosphoric acid fuel cells (PAFCs) were the first commercially available type, with over 200 units in operation as of 2003. PAFCs have efficiencies of up to 40%, with capacities ranging from 5kW to 50MW[8]. Other types of fuel cells currently under

development are proton exchange membranes (PEMFC) (already developed but not yet commercialized), molten carbonate (MCFC) and solid oxide (SOFC). Their varying degrees of waste heat temperatures and capacities will determine how they might best be utilized in various CHP applications.

Heat Recovery

As noted, combined heat and power systems offer significant energy savings by utilizing the excess thermal energy from the power production process to heat, cool, control humidity, and heat water in buildings. In most cases, a waste heat exchanger is used to recover the waste heat from the power production process, either from the engine cooling jacket or from the exhaust gases. This recaptured heat is used to produce hot water or steam, which is used to provide steam heating or hot water for nearby buildings, and/or may be used to operate thermally activated equipment, such as absorption chillers and desiccant dehumidifiers.

Thermally Activated Machines

Thermally activated machines use thermal energy, rather than electric energy, for heating, cooling, or humidity control for buildings. In CHP systems, the two key examples are absorption chillers and desiccant dehumidifiers.

Absorption chillers use recovered heat as the primary source of energy to cool water (for air conditioning) via an absorption refrigeration cycle (see "Resources for Further Information" for more detailed information on the absorption refrigeration cycle). Absorption chillers require very little electric power compared to electric chillers (0.02kW/ton versus 0.47 to 0.88kW/ton), and have very few (and small) moving parts, making them quieter than their electric counterparts.[9] Also, because they use water as a natural refrigerant, they are environmentally sound. Today's absorption chillers can also act like boilers by using recovered thermal energy for providing heat to buildings. These modern absorption chillers also feature controls to better control space heating more efficiently than electric chillers.

Absorption chiller

Space conditioning involves both sensible cooling (lowering the air temperature) and latent cooling (reducing the humidity level in the air). Desiccant dehumidifiers use either solid or liquid desiccant materials, which attract and hold moisture, to reduce humidity (see "Resources for Further Information" for more detailed information on liquid and solid desiccant systems). Heat recovered from the exhaust gases from power production can be used for regenerating the desiccant material in the dehumidifiers. Desiccant dehumidifiers can be used in series with absorption chillers to dehumidify and cool the air. They can utilize the waste heat in series as well, in a cascaded system in which the waste heat from the chiller regenerates the desiccant. In CHP systems, it may be preferable to first dehumidify the air with a desiccant dehumidifier, and then cool the air with cooling equipment. Since lowering the moisture content of the air has cooling effects, doing this first requires less energy for further cooling by the chiller.

Desiccant dehumidifier

Modular Packaged Systems (micro-CHP)

Modular packaged CHP systems, or micro-CHP, currently under development, offer great time, cost and energy savings potential for CHP on college and university campuses. These modular systems are compact and can be manufactured economically as "plug-and-play" systems designed to meet the individual power, heating, and cooling needs of particular buildings. Micro-CHP systems could be pre-engineered, skid-mounted systems, and building owners would only be responsible for connecting the power, piping, and ducting. Deploying such modular systems would greatly reduce the time and effort required to integrate power and thermal system components. The U.S. DOE is currently sponsoring the development, testing, and demonstration of several modular packaged CHP systems ranging in size from 60kW to 4.6 MW

System Integration and Sizing Options

Design and operation of an efficient and cost-effective CHP system are complex tasks, partly due to the availability of a large number of options in the portfolio of CHP technologies. The success of implementing these technologies for college/university campuses is ultimately measured with respect to energy efficiency and reliability, emission reduction, and economic return on investment that also form the criteria for system design and operation. The following discussions are intended to address some of the key concepts and issues surrounding system integration and sizing that play a critical role in meeting these criteria.

CHP Configuration

Estimating the electrical and thermal peak loads and profiles of a building or a group of buildings is a prerequisite to configuring and sizing a CHP system. Following the electrical and thermal load characterization, the configuration process commences by identifying subsystems/components and appropriate methods for their integration. In the design process of a CHP system, many options may be available with respect to system configuration, although initial screening and analyses usually lead to selection of a limited number of candidates. Arriving at an optimum system configuration often requires "what-if" analyses and an iterative approach for fine-tuning with the aid of a validated simulation model that can predict energy consumption, emissions, and life-cycle costs with reasonable accuracies.

Considering that the overall energy efficiency of a CHP system is largely influenced by the amount of waste heat utilization, selection and integration of thermally activated equipment are of great importance. The input energy requirements of the selected thermally activated equipment, such as desiccant dehumidifiers and absorption chillers, have to be compatible with the quantitative and qualitative availability of the waste heat resulting from on- or near-site power generation. Depending on the types of thermally activated systems, in certain scenarios, cascading these systems to achieve a higher thermal efficiency may be best. An example of cascading is integration of an absorption

chiller and a desiccant dehumidifier in such a way that the waste heat of the chiller is used for driving the desiccant dehumidifier, as opposed to using a fuel.

Centralization vs. decentralization of CHP

Centralization of cooling and heating systems for college/university campuses has been practiced for decades across the country. Campuses with such facilities are often good candidates for implementation of CHP technologies. Central CHP systems for campuses represent an expansion of the central cooling/heating concept. A CHP system, however, introduces additional complexities associated with optimum system design and operation. Issues surrounding maximum waste heat utilization, power reliability, and economics of purchasing and/or selling electricity to the utility are among these added complexities.

Depending on the campus layout, the proximity of the buildings, and the extent of new construction, a combination of centralized and decentralized CHP models may be economically more attractive for a campus. This consideration further raises the level of design and operational complexity. The cognizance of these issues, along with the diversities with the electrical and thermal load profiles of campus buildings, points to the need to investigate all available options in grouping the buildings for optimum or near-optimum design and allocation of decentralized CHP systems. In certain circumstances, as shown below, a decentralized CHP model (having multiple CHP systems) may be preferable.

- Distribution penalties: Installation of underground hot and chilled water distribution pipes from the central plant to all buildings of a large campus may not be feasible due to excessive distribution losses and high installation costs. For instance, university research parks that are separated from the main campus may require installation of a separate district CHP system or multiple mini/micro-CHP units.

- Load profile compatibility / complementary considerations: Campus buildings are likely to be diverse in terms of functionality and operating schedule, leading to vastly different electrical and thermal load profiles. For example, while the lighting and HVAC loads of a campus library or an architecture studio with extended hours may be at or near the peak level at 8:00 p.m. on a summer day, the loads of many unoccupied buildings may be minimal at that time. Such an incongruity would lead to inherently inefficient part-load operation of a central CHP system. Grouping the buildings with respect to electrical and thermal load compatibility and tailoring especially designated CHP systems may enhance the overall energy efficiency and the economics. The basis for categorizing the buildings may also be of a complementary nature that ensures maximum utilization of the waste heat.

- Retrofit projects: Upon construction of new buildings or expansion of existing buildings on a campus, increasing the cooling, heating, and electrical capacities of the central CHP plant that would also require addition of new distribution lines to meet the added loads may not be cost-effective. In such

cases, implementation of mini/micro-CHP technologies for each individual building may prove to be a viable option.

Sizing of a CHP system

The power generator of a CHP system can be sized and operated to meet either the thermal load, known as "thermal-load-following" or electrical load, referred to as "electrical-load-following." In the former case, depending on the thermal-to-electrical load ratio, the power supply may be more or less than the demand, leading to the sale or purchase of power from utility, respectively. The economic viability of this option largely depends on the utility rate structure for exchange of electrical energy. In the case of electrical-load-following, there may be times that the thermal energy output from the generators (prime movers) is in excess of the demand. In these circumstances, due to the lessened use of the generator waste heat, the energy efficiency of the system is adversely affected unless an energy storage technology is implemented to facilitate use of the excess heat at a later time when the thermal output is insufficient. The electrical-load-following model is the only option for grid-independent applications. In addition to these two models, a CHP system can also be designed and sized to partially meet the electrical and thermal loads of a building or a multi-building complex. This scenario is usually more prevalent in retrofit, trial, and demonstration projects.

Cost Effectiveness of CHP Systems

The cost-effectiveness of combined heat and power systems can be maximized by utilizing as much waste heat from the power production process as possible for heating water or controlling temperature and humidity levels in buildings. Several technology options are available for designing CHP for college and university campuses, with unique installed, operation, and maintenance costs. It is important to look at the costs of CHP over the life of the system to determine overall costs and potential cost savings. While initial costs of installing a CHP system may be higher than an equivalent conventional system, life cycle costs can be significantly lower due to vastly more efficient system operation. It is also important to keep in mind the energy efficiency of building equipment before installing a CHP system. A more energy efficient building will have a lower electrical load, thereby allowing for a smaller generator, and saving on overall costs.

Installed Equipment Cost

Capital investment, or installed cost of CHP systems includes the cost of installing power generation and cooling/heating/dehumidification equipment such as absorption chillers and desiccant dehumidifiers. As discussed earlier, several technology options exist for electricity production, including internal combustion engines, combustion turbines, microturbines, and fuel cells. The chart below shows installed cost in dollars per kilowatt and associated capacity ranges for these different technologies.

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Installed Costs of CHP Power Production Technologies

Note: The high end of the installed cost range indicates costs with NOx controls for the most severe emissions limits (internal combustion technologies only).

Technology	Installed Cost ($ / kW)	Size Range
Diesel Engine	350 - 800	1kW – 10MW
Natural Gas Engine	450 - 1,100	1kW – 5MW
Dual Fuel Engine	625 - 1,000	1kW – 10MW
Microturbine	950 - 1,700	25kW – 250kW
Combustion Turbine	550 - 1,700	300kW – 10MW
Fuel Cell	4,000 - 6,000	5kW – 50MW

Source: Laboratories for the 21st Century Best Practices

It is important to note that pricing of CHP equipment fluctuates, especially as advances are made, and so it is recommended that you contact the equipment manufacturers for accurate prices (visit http://www.bchp.org/owner-equip.html for equipment guide).

Many agree that installed capacity costs a re continuing to decline. The installed cost of microturbines, for example, is expected to be significantly lower within the next few years.

Installed Cost for Electric and Absorption Chillers

Chiller Capacity, RT (Refrigeration ton)	300	500	1000
	Installed Cost, $/ton[10]		
Electric Centrifugal	490 (air-cooled)	490 (w/ cooling tower)	460 (w/cooling tower)
Single-Effect Steam-Heated Absorption	600	530	490
Double-Effect Direct-Fired Absorption	1,000	850	790

Source: 2000 Means Mechanical Cost Data: http://www.rsmeans.com/

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Capital costs for desiccant dehumidifiers are reported in dollars per cubic feet per minute (CFM) since their sizing is based on airflow rate. Active solid desiccant systems range in cost from $4 to $9 per CFM capacity for air handling (depending upon total capacity and equipment enclosure requirement).[11]

Operation and Maintenance Costs

Determining operation costs of CHP systems requires estimating the power, heating, and cooling loads for the facilities that the system will serve. This can be a complex process accounting for numerous factors. Several software tools have been developed for evaluating these costs, including Building Energy Analyzer, BCHP Screening Tool (currently under development), and D-Gen Pro. See "Resources for Further Information" at the end of this chapter for links to these tools.

Maintenance costs for the various technological components of CHP systems vary and depend on equipment capacity. Costs may also depend upon the emission control system requirements for particular locales. Combustion turbines have among the lowest maintenance costs per unit of power output of all power generating technologies at $0.005 - $0.01/kWh for a full service maintenance contract. Maintenance costs generally run from $0.01 - $0.015/kWh for natural gas engines. Due to the smaller output, maintenance for micro turbines costs approximately $0.01 - $0.015/kWh. Maintenance costs for all of these are expected to go down as modular packaged systems become available. Fuel cell maintenance costs range from $0.003 to $0.015/kWh, not including the cost for replacing the fuel cell stock every five years, which is estimated at $0.04/kWh.

Maintenance costs for absorption chillers generally range from $18 to $31 per ton of cooling capacity per year, fairly close to that of electric chillers that range in cost from $19 to $28 per ton of cooling capacity per year.[12]

Operation and Maintenance Costs for Various Power Generation Technologies

Technology	Variable O&M ($/kWh)
Diesel Engine	0.025
Natural Gas Engine	0.025
Dual Fuel Engine	0.023
Microturbine	0.014
Combustion Turbine	0.024
Fuel Cell	0.01-0.05

Source: Laboratories for the 21st Century Best Practices

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Life-Cycle Costs

As mentioned earlier, because of the significant energy savings potential of CHP systems, life cycle cost is likely to be substantially lower than separate power and heating/cooling purchases. While installed cost might be higher, operation and maintenance costs are lower than conventional stand-alone systems. In order to calculate life-cycle cost of a system, the following data must be obtained: installed equipment cost, annual operating and maintenance costs, useful life of the equipment, equipment replacement cost, rate of interest, energy cost escalation, general inflation rate, utility charges (e.g., standby charges), and credits. It is important to compare these costs over the same period of useful life.

Additional information on implementing a CHP project can be found at http://www.eere.energy.gov/der/chp/chp-eval.html.

Case 1: SUNY Buffalo Uses Emerging Microturbine Technology for CHP

Project Background and Description:

The State University of New York campus at Buffalo (SUNYAB) has installed a combined heat and power system that will use emerging microturbine technology to produce electric power. Two 60-kilowatt Capstone microturbines, with exhaust gas heat recovery capabilities, provide electric power to pumps that continually circulate water in the university's competition swimming and diving pools in the Alumni Arena. Approximately 75 percent of the waste heat from the microturbines is recovered and utilized for heating the circulated water, virtually eliminating the need to use the existing electric heaters. The system is designed to pre-heat one million gallons of continuously circulating water in the pools.

The project partners in addition to SUNYAB are the New York State Energy Research & Development Authority, Gerster Trane Sales and Services, Inc., and the National Fuel Gas Distribution Corporation.

Benefits and Costs

Energy Savings: 2,000 MWh/yr in electricity
Costs: $620,000 for installation
Costs savings: $70,000/yr.

Project Financing

The New York State Energy Research & Development Authority (NYSERDA) under its Distributed Generation/Combined Heat & Power Program provided $310,000 in incentives. The balance was provided by grants from Gerster Trane and National Fuel Gas. NYSERDA's funds come from its New York Energy $mart program, which is designed to lower electricity costs by encouraging energy efficiency as the state's utilities moved to competition. The program is available to all electric distribution customers of the state's six utilities.

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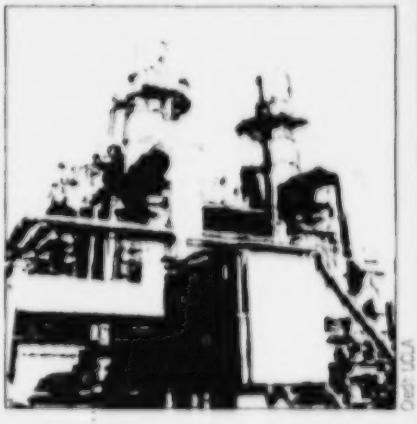
Case 2: University of California Los Angeles Uses Landfill Gas to Heat, Cool, and Power its Campus

Project Background and Description

Faced with rising energy needs, aging cooling equipment, and decreased state funding, the University of California Los Angeles (UCLA) decided it needed to develop new sources of energy that increased system reliability and energy efficiency, minimized environmental impacts, and reduced costs. UCLA determined that a combined heat and power plant that utilized a blend of natural gas and landfill gas was the best option for meeting those objectives.



Credit: UCLA

UCLA's CHP system is comprised of two 14.5 MW combustion turbine generators fueled by 65% natural gas and 35% landfill gas, two heat recovery steam generators driven by the combustion turbines, one condensing steam turbine electric generator, two steam turbine-driven centrifugal chillers and one electric chiller, and four single stage absorption chillers for additional chilled water production. The system produces 250 GWh of electricity (85% of the campus' electrical needs), 730 billion BTUs of heat, and 870 billion BTUs of cooling per year that is delivered to more than 100 campus buildings, including teaching and research facilities, a sports arena, a major teaching hospital, and other facilities.

Environmental Benefits

- Reduced overall campus emissions by 34%
- Reduction in smog-forming pollutants by 36 tons annually
- 4 million cubic feet of landfill gas converted daily from waste gas to fuel
- Elimination of 20,000 lbs of CFCs
- Meets a 6 parts per million (ppm) NOx standard
- Potable water usage reduced by 60% (70 million gallons per year) by recycling gray water

Costs and Cost Savings

- Replacement of 1/3 natural gas usage with landfill gas results in $250,000 annual savings
- Initial investment of $188 million will be paid off over 22 years, after which the CHP system will provide $25 million in savings over the remainder of its life.

Combined Heat and Power

Other Benefits

In addition to numerous environmental and cost savings benefits, UCLA's CHP system is capable of supplying emergency power to the Los Angeles community. When thousands of Los Angeles residents lost power during the 1994 Northridge earthquake, the UCLA system was able to supply 20,000 homes with power[13].

Project Financing

Since state funding was limited, the university decided to issue Certificates of Participation to lenders, which are essentially loan agreements paid back with operating savings from the system (similar to a performance contract).

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Case 3: University of Maryland: Bonding/CHP Profile

Project Background/Description

Final commissioning is now under way for the newly renovated CHP plant to upgrade the campus central steam plant. The plant has two sets of heat recovery steam generators, two combustion turbines, and a back pressure steam turbine to generate electricity and steam. Two existing boilers also have been upgraded.

In the mid-1990s, a campus energy audit showed a need for upgrades totaling $70 million but state funds were lacking. An extensive energy analysis determined that savings derived from a combined heat and power plant upgrade of aged steam and condensate distribution systems, and implementation of a centralized chilled water plant for the science and technology area of the campus, would provide energy and maintenance savings to adequately fund the capital requirements of the project. The University executed a contract with Maryland Economic Development Corporation (MEDCO), which went out to bid for a firm to construct and run the CHP plant for 20 years. Trigen Cinergy Corporation, Inc., was the successful bidder.

The plant will provide 27MW of power for the campus except when marketplace prices are more advantageous. The plant also produces steam heat and chilled water for 16 high demand buildings. When at full capacity, the turbines meet the campus's wintertime electric demand and 65 percent of its summer requirement. The plant produces 100 percent of the campus steam requirement and about one-third of its chilled water requirement.

Benefits and Costs

Energy Savings: 32 percent decrease in BTUs anticipated
Environmental Benefits: Up to 1/3 decrease in campus water use is anticipated.
Costs: $73 million project cost with a 20-year payback

Project Financing

MEDCO floated $73 million in bonds as the project's owner and operator of record. The bonds are being repaid through the energy efficiencies realized over a 20-year payback period, thus allowing the University system to show the project as off balance sheet financing. The project cost included not only plant construction but also improvement of existing electrical distribution, steam distribution systems and the construction of a chilled water plant and a chilled water distribution system. After 40 years, the plant becomes the property of the university.

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Resources for Further Information

Additional case studies of CHP at colleges and universities can be found at
http://www.districtenergy.org

Absorption chiller refrigeration cycle and desiccant dehumidifiers:
http://www.bchp.org/status-4-owner.html

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbooks:
http://www.ashrae.org

Building Energy Analyzer software:
http://www.interenergysoftware.com/

Cooling, Heating, and Power for Buildings:
http://www.bchp.org

D-Gen Pro economic feasibility software:
http://boulder.archenergy.com/dgenpro/

EPA's Combined Heat and Power Partnership:
http://www.epa.gov/chp/

International District Energy Association:
http://www.districtenergy.org

Midwest CHP Application Center:
http://www.chpcentermw.org/home.html

National Renewable Energy Laboratory's Advanced Desiccant Cooling and Dehumidification Program's Web site:
http://www.nrel.gov/desiccantcool

Northeast-Midwest Institute:
http://www.nemw.org

University of Maryland CHP Integration Test Center:
http://www.enme.umd.edu/ceee/bchp

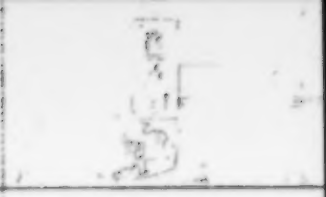
U.S. Combined Heat and Power Association:
http://www.nemw.org/uschpa

U.S. Department of Energy Office of Distributed Energy Resources:
http://www.eere.energy.gov/der/

Footnotes

1 Cooling, Heating, and Power for Buildings. http://www.bchp.org/owner-basic.html
2 Cooling, Heating, and Power for Buildings. http://www.bchp.org/policy-barrs/it.html
3 EPA CHP Success Stories. http://www.epa.gov/chp/chp_success.htm
4 Cooling, Heating, and Power for Buildings. http://www.bchp.org/slides-2-owner.html
5 National Renewable Energy Laboratory
6 ibid. The actual net efficiency ranges from about 20% to 25% based on a number of test reports.
7 Note that fuel reforming (in this case processing natural gas into purified hydrogen) consumes energy and cuts the net efficiency. With continued research and development, hydrogen production and fuel cell power output may see great gains in efficiency.
8 ibid.
9 Cooling, Heating, and Power for Buildings. http://www.bchp.org
10 These cost estimates include overhead and profit. For labor and material costs only, deduct 11%. Costs may vary by location. Consult 2000 Mechanical Cost Data or a manufacturer for more accurate estimates for your area.
11 Cooling, Heating, and Power for Buildings. http://www.bchp.org
12 ibid.
13 International District Energy Association

Emissions Markets



- Overview
- Air Pollution and Climate Change programs
- Opportunities for Colleges and Universities to Participate in Emissions Markets
- Opportunities for Colleges and Universities to Participate in Air Pollution Markets
- Case Study University of Colorado
- Resources

Overview

Harnessing of market forces to drive environmental compliance has occurred through emissions trading since the signing of the Clean Air Act. Various approaches to emissions trading allow pollution sources to buy and sell credit and create allowances for offsets of air pollutants. Air pollution markets include trading of criteria pollutants such as sulfur dioxide (SO2) and nitrogen oxides (NOx).

In some cases, emissions markets are also being created to include the trading of greenhouse gases (GHG) such as carbon dioxide (CO2). Certification programs reward the emission reductions that accompany energy efficiency and renewable energy. Though GHG registry programs do not currently create marketable credits for emissions reductions, they could prove important in gaining future financial benefits from emissions reductions implemented today, or demonstrating opportunities for these types of activities in future emission allowance or credit markets.

Each of these mechanisms can provide both environmental and economic benefits for colleges and universities. This chapter provides a brief summary of emission markets and opportunities for colleges and universities to participate in these markets. It focuses on opportunities for colleges and universities to obtain and sell credits for projects that reduce emissions of greenhouse gases and local air pollutants.

Air Pollution and Climate Change Programs

National

The 1990 Clean Air Act (CAA) amendments is a federal law under which the Environmental Protection Agency (EPA) sets limits on how much of a pollutant can be in the air. Limits are set on NOx and SO2. The CAA gives the states the primary authority to manage their air quality resources; states can have stronger pollution controls than those set for the nation. To ensure some consistency from state to state, EPA requires air pollution control agencies to develop plans based on broad federal statutes and regulations. For example, states are required to develop State Implementation Plans[1] (SIPs) that explain how each state will do its job under the CAA.

Introduction of proposed Clear Skies legislation would create a mandatory program that would reduce power plant emissions of SO2, NOx, and mercury by setting a national cap on each pollutant. More information on the Clear Skies Act, including proposed caps for pollutants, can be located at http://www.epa.gov/air/clearskies/fact2003.html .

Emmissions Markets

Clean air markets programs in the U.S. include various market-based regulatory programs designed to improve air quality. The most well-known of these programs is EPA's Acid Rain Program, which has the overall goal of achieving environmental and public health benefits through reductions in emissions of SO_2 and NO_x – compounds produced by fossil fuel combustion that adversely affect air quality, the environment, and public health.

Acid Rain Program: SO2 Allowances

Allowance trading provides incentives for energy conservation and technology innovation that can both lower the cost of compliance and yield pollution prevention benefits. The centerpiece of EPA's Acid Rain Program is allowance trading. Allowances are the currency with which an institution achieves SO2 emission requirements. Within the Acid Rain Program, facilities can reduce emissions through adding pollution control technologies, switching to lower sulfur fuel, or developing alternate strategies. By reducing emissions below the number of allowances held, those extra allowances may be traded with others, sold to other facilities through EPA auctions[2], or banked to cover emissions in future years.

Prices for this tradable instrument are well established since SO_2 allowances are the most actively traded emissions commodity. Historically, prices have ranged from about $65/ton to slightly over $200/ton. September 2001 prices ranged from $208 to a peak of $218 per ton. Further price and volume information is available from Natsource, as well as other brokers in these markets. Forty-one percent of trades on SO_2 are conducted between organizations, and 55% of these transactions occur via brokers, with greater than 14 million exchanges in 2000.

Universities and colleges can purchase allowances directly from a company or individual who holds them. Three additional means of purchasing allowances are: through EPA's annual auction conducted by the Chicago Board of Trade, through a broker, or through environmental groups that "retire" allowances.

An additional air pollutant-trading program is EPA's NOx Budget Trading Program, or the NOx SIP Call. The Clean Air Markets Division of the EPA records allowance allocations in a tracking system according to specifications of each state. The states for which allocations have been recorded are: Massachusetts, New Jersey, Pennsylvania, New York, and Indiana.

Regional

Regional Haze Program

In 1999, the EPA announced a major effort to improve air quality in national parks and wilderness areas. The Regional Haze Rule calls for state and federal agencies to work together to improve visibility in 156 national parks and wilderness areas. Five multi-state regional planning organizations are working together to develop the technical basis for these plans.

The five regional planning organizations are: Western Regional Air Partnership (WRAP), Central States Regional Air Partnership (CENRAP), Midwest Regional Planning Organization (Midwest RPO), Mid-Atlantic/Northeast Visibility Union (MANE-VU), and the Visibility Improvement State and Tribal Association of the Southeast (VISTAS).

Regional Planning Organizations

Source: Penobscot Nation Department of Natural Resources

State and Local

In the United States, more than 20 states, 200 cities, and several hundred major corporations have adopted programs or policies aimed at reducing GHG emissions. All of the programs are voluntary and have jurisdictional limitations.

If, currently, the programs are voluntary, why should colleges and universities be interested in emissions information if state agencies are not regulating GHGs? States have become interested in encouraging actions that address climate change in general and GHG emissions in particular. Through a mix of education and incentives, states are looking to leverage emissions information to motivate organizations to account for and reduce their emissions. In areas where market programs to reduce emissions are undergoing development, colleges and universities can take steps now to prepare for eventually benefiting in program participation. Preparation is possible by collecting current emissions data and reductions. This can be done in isolation; however, additional benefits may result from participating in organized, voluntary registries.

Registries

Emissions reduction trading requires an emissions trading registry. Similar to financial exchanges for stocks and bonds, an emissions trading registry will facilitate a market for emissions reduction credits. There are several registries in the United States including: the Clean Air Action Corporation Registry, the State of Michigan, the Northeast States for Coordinated Air Use Management (NESCAUM) Demonstration Project, the Airbank, and the California Climate Action Registry (CCAR).

Emmissions Markets

CCAR is an example of a voluntary registry created by a state to address GHG emissions. Legislation in 2000 created CCAR as a non-profit with the purpose to help organizations with operations in California to establish GHG emissions baselines against which any future GHG emission reduction requirements may be applied.

Participants are encouraged to increase energy efficiency and decrease GHG emissions through voluntary actions. GHG emission inventories are recorded using any year from 1990 forward as a base year. The State of California will offer its best efforts to ensure appropriate consideration for early actions by participants are considered in the event of any future GHG regulatory schemes.

For the first three years of participation, CCAR will require the reporting of only CO2 emissions, though additional reporting is encouraged. The reporting of all six GHGs covered in the Kyoto protocol[3] is required after three years of participation in the registry. The University of California-San Diego (UCSD) is a charter member of the California Climate Action Registry.

By 2002, 12 states had enacted or were considering establishment of GHG registries. These states are: California, Connecticut, Iowa, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Texas, Vermont, and Wisconsin. These 12 states have formed a collaborative, facilitated by the EPA, to share experience and coordinate policy and reporting approaches where possible.

Additionally, the following participate in the collaboration mentioned above: Northeast States for Coordinated Air Use Management (NESCAUM), the Energy Foundation, and NGOs such as Clean Air- Cool Planet, Climate Neutral Network, Environmental Defense, Natural Resources Defense Council, Public Citizen, Union of Concerned Scientists and World Resources Institute.

Opportunities for Colleges and Universities to Participate in Emissions Markets

Emission Trading: 101

For universities and colleges, emissions trading is successful because it involves the application of pollution reduction measures where these reductions are most cost effective. Applicable measures can include renewable energy integration, building design and planning, fuel switching, control technologies, equipment improvements, energy efficiency measures, and any other activity that produces a measurable decrease in air emissions. Once recorded, these measures can be potentially used as credits against future emissions reductions requirements, especially in those cases where measures have been taken to verify claimed reductions by a third party. Rather than applying costly compliance controls, tradable credits can be used as a more cost effective strategy, as long as these credits represent equivalent real reductions made elsewhere.

Emissions Markets

In order for university and college managers to participate in emissions trading, the following is required: a seller, reductions to sell, a buyer, and a market in which to make the transaction. Market creation is largely motivated by government regulation at the national, state, or local level, and buyers in emissions trading markets are usually producers of those pollutants wishing to find the most cost effective means to achieve an environmental objective, and in an extreme case to avoid regulatory penalties.

The markets for these reduction credits are not only diverse in terms of pollutants reduced, but also in terms of geography, scope, and administration. For the purposes of this section, the focus will fall on three main types of emissions trading systems: open market, multi-source cap-and-trade markets, and offset trading.

Open Market Emissions Trading

Open market emissions trading provides incentives for voluntary reductions of air contaminant emissions in return for the ability to sell the reductions achieved. Open markets can include regulated operations, such as colleges and universities, which are not large enough to be included in a typical cap-and-trade market.

Credits are created under an open market system when facilities voluntarily reduce their emissions over a finite period of time[4]. The reductions can be traded to other facilities that need to comply with certain regulatory limits. Groups or private individuals may also voluntarily retire emissions credits to permanently reduce emissions opportunities.

Multi-Source Cap-and-Trade Markets (Allowance Trading)

Under this system, an annual area-wide emissions limit or cap is established for a defined region of air pollution sources, with a reduction schedule set over time. Shares of this cap are typically distributed to sources of emissions in the form of allowances. Under this system, sources that emitted the most pollution in the past are rewarded with the most allowances and penalized with the greatest need to reduce emissions. Each participating source must possess enough allowances at the end of the annual compliance period to equal their emissions. Unused allowances can be banked for future use, traded, retired, or sold.

The EPA's Acid Rain Program is the most well known example of an allowance trading program. Other examples of allowance trading are the NOx budget programs established by the Ozone Transport Commission (OTC) in the northeastern United States, and the Ozone Transport Assessment Group.

Offset Trading

Offset programs were developed under EPA's New Source Review (NSR) program. Under offset programs, new or modified sources such as major new construction projects must install the most stringent level of control technology available, and also provide additional emissions reductions (offsets) generated by neighboring sources to alleviate the projected additional emissions.

Emmissions Markets

An emission offset is a permanent reduction in a source's emission rate. Offsets can be created by installing advanced technology controls beyond regulatory requirements, or by permanent shutdown of an air pollution source. Many companies and political jurisdictions currently hold offsets, which are available for sale, or in certain instances, are offered to applicable sources free of charge.

National GHG markets

Greenhouse gas trading has emerged in recent years as concern over climate disruption has widened. Interest in participating in international schemes has created interest in marketplaces like the Chicago Climate Exchange and other online market places. Anticipation of imminent regulation of CO2 and other GHGs at the federal level has motivated interest in state GHG registries, which cater to those who believe that early actors will be rewarded under future carbon contained scenarios.

Verified emission reductions have been traded domestically and internationally fall from between $0.50 and $3.50 per metric ton of CO2. In virtually all cases the price of the reduction corresponds closely with its "quality" meaning verifiability and other attributes that strengthen its potential for credit under future compliance regimes. For U.S. domestic markets, the primary concern of the buyer is some reasonable assurance that a future policy or program requiring emission reductions will honor both the reductions claimed and the baseline against which it is being compared.

Currently, the Chicago Climate Exchange is not operational; however, announcement of a start date is planned for summer 2003. The Chicago Climate Exchange is conversing with several colleges and universities in all 50 states regarding membership. Membership involves committing to the target reduction of 4% below the average emission rates during the 1998-2001 timeframe; tracking emissions; and reducing emissions by 1% each year until the end of the program – in four years. Additional reductions achieved are then marketable to partners within the exchange.

The Chicago Climate Exchange "believes in a multi-sector approach" to emissions reductions, and believes "participation from colleges and universities is important because the formation of human capital occurs there."[5]

Key Features of the Chicago Climate Exchange:

Geographic coverage	U.S. emission sources and offset projects in the U.S. and Brazil. Sources and projects in Canada and Mexico to be added during 2003
Emission targets and timetable	Emission reduction commitments for years 2003 through 2006. Emission targets are 1% below baseline during 2003, 2% below baseline during 2004, 3% below baseline during 2005, 4% below baseline during 2006.
Emission baseline	Average of annual emissions during years 1998 through 2001.
Gases included	CO_2, CH_4, N_2O, PFCs, HFCs, SF_6
Emission offsets	Landfill and agricultural methane, sequestration in soils and forest biomass. Other project types accepted from Brazil.
Early Action Credits	Credits from specified early projects to be included starting in 2004.
Registry, Electronic Trading Platform	Registry will serve as official holder and transfer mechanism, and is linked with the electronic trading platform on which all trades occur.
Exchange Governance	Self-regulatory organization overseen by Committees comprised of exchange Members, directors and staff.

Source: Chicago Climate Exchange http://www.chicagoclimatex.com

This program was to be set up in phases, with the launch of the program in 2002 after the design phase completion. Phase I is occurring in 2003, with commitments and trading by participant beginning in the entire Unite States, Canada and Mexico. Phase II will take place between 2003 and 2006, and is a continuation of the first phase. Phase III is planned to begin in 2004, and will expand international linkages.

Examples of Greenhouse Gas Mitigation and Offset Projects in the Chicago Climate Exchange

Renewable energy systems such as wind and solar

Energy efficiency process innovations

Carbon sequestration: no-till farming, agricultural grass and tree plantings

Switching to less greenhouse gas intensive fuels

Recovery and use of agricultural and landfill methane

Vehicle fleet efficiency improvements

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Emmissions Markets

Regional and State GHG markets

The Climate Trust, formerly the Oregon Climate Trust, is a 501(c)(3) non-profit, and was created in 1997. Their mission is to promote climate change solutions by providing high quality GHG offset projects and advance sound offset policy. The climate Trust plays a key role in implementing Oregon's innovative CO2 standard, which became the first legislation regulating GHG nationwide.

This standard requires new power plants to offset approximately 17% of their CO2 emissions. A plant developer may choose to meet part or all of its reduction target by paying mitigation funds to a qualified non-profit, such as the Climate Trust, which in turn must use the funds to carry out projects that avoid, sequester, or displace the CO2 the plant will emit in excess of the required standard. The Climate Trust uses the funds to acquire and manage contracts for offset projects from mitigation measures such as renewable energy, energy efficiency, energy system decarbonization, and forest carbon sequestration.

To date, the Climate Trust has contracted for five offset projects totaling 850,000 metric tons of CO2. With the addition of seven more offset projects currently under negotiation, the Climate Trust's offset portfolio will total almost $7 million and 3.5 million metric tons of CO2.

Opportunities for Colleges and Universities to Participate in Air Pollution Markets

Green Certification Programs

Colleges and universities can purchase green certificates, and potentially develop projects that contribute to green certificate programs. An example of a green certification program is the Cleaner and Greener[sm] Environment program.

Cleaner and Greener[sm] Environment, a program of Leonardo Academy, is a 501(c)(3) environmental nonprofit organization. Leonardo Academy reports reductions in emissions, and promotes the development of markets for the emission reductions that result from energy efficiency, renewable energy, and other emission reduction actions.

The Cleaner and Greener[sm] Environment Program has four main objectives:

To provide recognition, through the Cleaner and Greener[sm] Certification Program, for businesses and organizations that reduce emissions by implementing energy efficiency and renewable energy projects;

To demonstrate that people want the low cost emission reductions provided by energy efficiency and renewable energy;

To open up environmental regulations to include emission reductions from energy efficiency and renewable energy; and

To demonstrate that low cost emission reductions are available from energy efficiency and renewable energy.

There are five levels of certification including supporting the Cleaner and Greener℠ Principles, reporting emissions reductions, retiring emission reduction credits, requesting that suppliers and customers participate, and calculating and offsetting emissions at an organization. The Certification Program calculates emission reductions and estimated annual cost savings results. Based on individual energy efficiency efforts, calculations result in the following pollution reductions: Pounds of Greenhouse gases (CO2), Volatile Organic Compounds (VOC), Nitrogen Oxides (NOx), Carbon Monoxide (CO), Sulfur Dioxide (SO2), Particulates (PM10), and milligrams of mercury (Hg).

Cleaner and Greener℠ Certification makes it easy for consumers to identify organizations that are taking positive environmental action. Consumers can take pollution reduction to a higher level through buying and retiring emission reduction credits to their offset emissions. Regis University in Denver, Colorado, is a Supporter of the Cleaner and Greener℠ Principles.

Overview of NOx Trading Programs

The goal of all NOx trading programs is to reduce the transport of ground-level ozone across large distances. The programs developed through various mechanisms, leading to differences in programs such as compliance period variations and expected reductions in different states[6].

Eastern states have a unique opportunity to reduce GHG emissions while providing other economic and environmental benefits and lowering the cost of compliance with air quality standards. Colleges and universities may earn credits through energy efficiency and renewable energy project implementation. This opportunity is established as part of a rule to mitigate ground level ozone. States can establish a set-aside of allowances for energy efficiency and renewable energy in the NOx Budget Trading Program.

Emmissions Markets

States with Emissions Tracking & Credit Computations Mechanisms

(The following states have put set-asides in place, which will be operational by the dates noted.)

State	Operational Date	Credit Computation	Aggregation
Indiana	By 2004 Ozone Season	Calculation for converting energy savings or renewable generation into tons of emissions for allowance allocation purposes: (kWh saved during the entire ozone season * 0.0015) / 2000, (lbs / Ton); or 0.0015 lbs / kWh. Allowances are in single-ton units.	Aggregation of emission reductions across several sources is permitted.
Massachusetts	By 2003 Ozone Season	For energy efficiency projects, whole-ton allowances will be generated at a rate of 0.0015 lbs / kWh saved.	Aggregation is encouraged.
Maryland	By Summer 2003	Still under discussion internally.	Aggregation will likely be allowed.
New Jersey	By 2003 Ozone Season	Credits are in single ton units with a conversion factor of 0.0015 lbs. / kWh.	Aggregation is possible.
New Hampshire	Proposed for 2003 Ozone Season	The conversion factor for allowances are derived from the kWh of renewable generation or kWh saved compared to the previous year's ozone season, multiplied by the previous year's annual average NEPOOL marginal emissions rate for NO_x.	There are no rules for aggregation of renewable energy projects.
New York	By 2003 Ozone Season	Credit computation is under development, but will remain a flat rate, most likely 0.0015 lbs / kWh.	No information available.

Source: "Emissions Tracking and Crediting Mechanisms at the State and Federal Level", Dec 2002. Prepared by GETF and NREL for EPA and DOE-FEMP.

In 2001, the EPA and the Federal Energy Management Program (FEMP) began a pilot project to explore opportunities for federal agencies to participate in emissions markets. After researching emissions trading programs in the United States, a NOx emissions market pilot project was pursued. The project currently seeks to aggregate the NOx emission reductions from the pilot facility with other federal facilities within the pilot state. Results of this pilot project may provide useful insight to colleges and universities in their quest to participate in emissions trading markets, especially related to aggregation of emissions reductions from several projects within a state.

Emerging Markets

The Market Trading Forum (MTF) of the Western Regional Air Partnership (WRAP) developed the details of an emissions trading program to achieve cost-effective reductions from industrial sources of SO2. Emissions milestones were set for SO2 between now and 2018 and a trading program was designed for use in the event the emission targets are exceeded. The trading program is triggered one year following the determination that a milestone is exceeded. Allocations are determined for each source for the fifth year following the triggering. All sources must be in compliance by the end of the fifth year. Before triggering

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of the trading program occurs, a source that reduces its emissions below its 2018 allocation can bank the early reduction and sell it later if the program is triggered. These are called bonus allocations. The Forum is also examining effective market approaches to address other industrial emissions, such as NOx and Particulate Matter (PM).

How to Participate

Universities and colleges can participate in emissions markets by purchasing and retiring credits, participating in EERE set aside NOx SIP call, participating in registries, documenting inventory emissions, or by complying with environmental regulations for air pollution.

Under both the Acid Rain Program and the Ozone Transport Commission NOx Budget Program, anyone can purchase allowances, including colleges and universities. Some individuals and groups purchase allowances as an environmental statement, because withholding allowances from the market prevents those allowances from being used by emitting sources. Keeping an allowance off the market achieves the same environmental effect whether you buy the allowance through the EPA Auction, an environmental group, or a broker.

Emmissions Markets

Case Study: University of Colorado, Boulder Campus Carbon Emissions Inventory

Project Background and Description
The University of Colorado undertook an emissions inventory comparing carbon dioxide emissions from 1990 to 1999 to discover how the cogeneration plant and increased energy demand has effected emissions.

Included in the inventory
CO_2 emissions due to heating, cooling, and providing electricity to campus buildings;
CO_2 emissions due to campus fleet vehicles; and carbon equivalent due to leakage of natural gas in pipelines.

Benefits and Costs
The University's calculation showed emissions decreasing 5.2% over the ten-year span. In comparison, electricity use has increased 4-5% every year.

Project Financing
Internal

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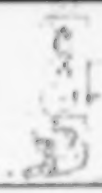

Resources for Further Information

Clean Air - Cool Planet:
http://www.cleanair-coolplanet.org/for_campuses.php

Chicago Climate Exchange:
http://www.chicagoclimatex.com/

Cleaner and Greener℠ Certification:
http://www.cleanerandgreener.org/index.htm

California Climate Action Registry:
http://www.climateregistry.org/

The Climate Trust:
http://www.climatetrust.org/

Clean Air Conservancy:
http://www.cleanairconservancy.org/

STAPPA/ALAPCO:
http://www.cleanairworld.org/scripts/stappa.asp

United Nations:
http://unfccc.int/resource/convkp.html

International Emissions Trading Association:
http://www.ieta.org/

US EPA:
http://www.epa.gov/airmarkets/index.html

US DOE:
http://www.eia.doe.gov/

Footnotes

1 A SIP is a plan that provides for implementation, maintenance, and enforcement of primary standards in each air quality control region within a state. The states are required to involve the public in development of each SIP. The EPA must approve each SIP; if a SIP is not approved, the EPA can take over enforcement of the CAA in that state.

2 EPA auctions a certain number of allowances annually at the end of March. Utilities, environmental groups, allowance brokers, and others interested in purchasing allowances can participate. Allowances are sold to the highest bidder until no allowances remain. Successful bidders are notified by telephone and are listed on the EPA website.

3 The six GHGs covered in the Kyoto Protocol are methane (CH_4), hydrofluorocarbons (HFCs), nitrous oxide (N_2O), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

4 These credits are generally called Discrete Emission Reductions (DERs), or in some states, the term Emission Reduction Credits (ERCs) is used.

5 When contacted, the Chicago Climate Exchange provided this statement. For more information on memberships, contact Rafael Marques at rmarques@chicagoclimateexchange.com

6 For a summary of the key differences among state programs, please visit EPA's website:
http://www.epa.gov/airmarkets/fednox/index.html

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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. By investing in technology breakthroughs today, our nation can look forward to a more resilient economy and secure future.

Far-reaching technology changes will be essential to America's energy future. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a portfolio of energy technologies that will:

- Conserve energy in the residential, commercial, industrial, government, and transportation sectors
- Increase and diversify energy supply, with a focus on renewable domestic sources
- Upgrade our national energy infrastructure
- Facilitate the emergence of hydrogen technologies as vital new "energy carriers."

The Opportunities

Biomass Program
Using domestic, plant-derived resources to meet our fuel, power, and chemical needs

Building Technologies Program
Homes, schools, and businesses that use less energy, cost less to operate, and ultimately, generate as much power as they use

Distributed Energy & Electric Reliability Program
A more reliable energy infrastructure and reduced need for new power plants

Federal Energy Management Program
Leading by example, saving energy and taxpayer dollars in federal facilities

FreedomCAR & Vehicle Technologies Program
Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle

Geothermal Technologies Program
Tapping the Earth's energy to meet our heat and power needs

Hydrogen, Fuel Cells & Infrastructure Technologies Program
Paving the way toward a hydrogen economy and net-zero carbon energy future

Industrial Technologies Program
Boosting the productivity and competitiveness of U.S. industry through improvements in energy and environmental performance

Solar Energy Technology Program
Utilizing the sun's natural energy to generate electricity and provide water and space heating

Weatherization & Intergovernmental Program
Accelerating the use of today's best energy-efficient and renewable technologies in homes, communities, and businesses

Wind & Hydropower Technologies Program
Harnessing America's abundant natural resources for clean power generation

To learn more, visit www.eere.energy.gov

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